COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC.

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A LITTLE JOB OF PNEUMATIC SUBAQUEOUS TUNNELING

An interesting narrative of practical engineering was comprised in a paper by Herman W. Spooner, of Gloucester, Mass., read before the New England Water Works Association. The following is abstracted and much condensed from the paper referred to.

The contract required the construction of two vertical masonry shafts, interior diameter 11 ft., one on each side of a canal, the shafts to be surrounded to within a few feet of the surface by steel cylinders, and a tunnel 9 ft. interior diameter, having a brick wall 1 ft. thick encased in a cylinder of steel plates, was to be constructed between these vertical shafts.

A circular excavation was begun for the easterly shaft, sheathed with matched plank 2 in. in thickness, the sheathing being supported by rings of 4-in. channel, leaving an opening in the clear of 13 ft. 9 ins. in which to operate. At a depth of 10 ft. boulders were encountered in the coarse gravel, which were removed after blasting; water immediately began to enter the excavation in small volume and was removed by a 3-in. pulsometer pump. At a depth of 18 ft. a decided change was noted in the material, fine dead sand being found, and a decided increase in the quantity of water was evident.

When a depth of 19 ft had been reached, the shoe-piece of the cylinder, with a special reinforced cutting edge upon which the masonry lining wall was to be constructed, was placed in position within the sheating and a second section of the cylinder was then adjusted, and so on. In the sinking of the cylinder the usual and some unusual difficulties were encountered. The volume of water entering the excavation rapidly increased, and as the tide turned the laborers were obliged to leave the bottom on account of the absence of pumps of sufficient capacity.

It was the intention of the contractor to complete the work without the use of compressed air, treating the ground through which the work was to be built with cement grout, this method being less expensive and having been used to advantage in other and similar work. Here, however, it was found that the nature of the gravel was such that the ground waters at all times moved freely through the ground, so that there was no opportunity at any time to leave grout in place for a sufficient period to allow of its attaining the initial set; therefore the contractor decided to resort to the use of the pneumatic method of construction. At this time the bottom or cutting edge of the cylinder was about 7 ft. below low-water mark, it being necessary to lower the structure about 20 ft. further before the required depth was reached. During the next two days the cylinder was worried down to a bed consisting of very coarse, hard gravel and isolated to a depth of 28 ft. below the surface of the park.

A recess was cut in the concrete lining to receive the wooden deck which was to support the compressed air tube and lock, and work in the east shaft was abandoned until the apparatus, air compressor, additional boilers, etc., could be assembled.

The cylinders to be placed within the excavation on the west side of the canal were rolled across the drawbridge and placed in correct order inside the sheathing. The inside of this cylinder was treated in the same manner as was the one on the opposite shaft and the walls constructed of concrete, an air deck, 18 in. in thickness, being built into the walls as the work progressed.

The pumping apparatus was moved to the west shaft and an attempt made to work this cylinder to a greater depth than was reached in the east shaft, but when a level had been reached which was within a fraction of an inch of the level of the bottom of the first shaft, the contractor was forced to abandon operations and wait for the application of compressed air.

While work was being carried forward on the westerly side of the canal, a small compressor with a receiver had been installed near the derrick on the east side of the canal, and on May 27 the air-lock and tubing especially designed and built for this work arrived and were ready, together with the head-house, and in operation, four days thereafter. Previous to this time there had been very little continuous work, and as when using the pneumatic method there is a continuous expense to maintain a dry excavation, two shifts were organized. Each shift worked eleven hours and consisted of foreman, stationary engineer, fireman, lock-tenders, miners, tenders, and muckers, generally eleven men being employed during each shift. The men employed upon this work were of the first rank in their several vocations, exercising great care in the performance of the duties assigned to them, and on this account, if for no other reason, the writer is pleased to be able to state that there were no men injured during the execution of this contract, and the final result is entirely satisfactory.

The air compressor was in operation thereafter continually until the work was nearly completed. All materials were removed, and all materials required in construction were transferred, through the air-lock, thus increasing the cost of construction nearly four-fold.

The cylinder was bound in such a manner that although the gravel was excavated from beneath the cylinder to a depth of 3 ft. and additional weight was added in the form of water on the deck and piles of brick upon the rim, it did not drop until all the air-pressure had been removed and the earth at the sides of the cylinder commenced to heave inward. This passage of gravel or "heave" from around the cylinder and about the sheathing down and into the void excavated, and into which it was desired to drop the structure, caused trouble throughout the entire lowering of this shaft, also until the tunnel was completed about 10 ft. from the side or eye. Often after working for an entire shift, when air pressure was removed, a net gain in depth of only 1 ft. was made, while at other times only 3 ins. were gained.

Poling boards were used beneath and in the rear of the cutting edge to hold back the material, which had a decided tendency to heave, but with little effect. In some instances over 4 ft. of sand and gravel rushed in when the pressure was removed, requiring nearly an entire shift of work to remove it.

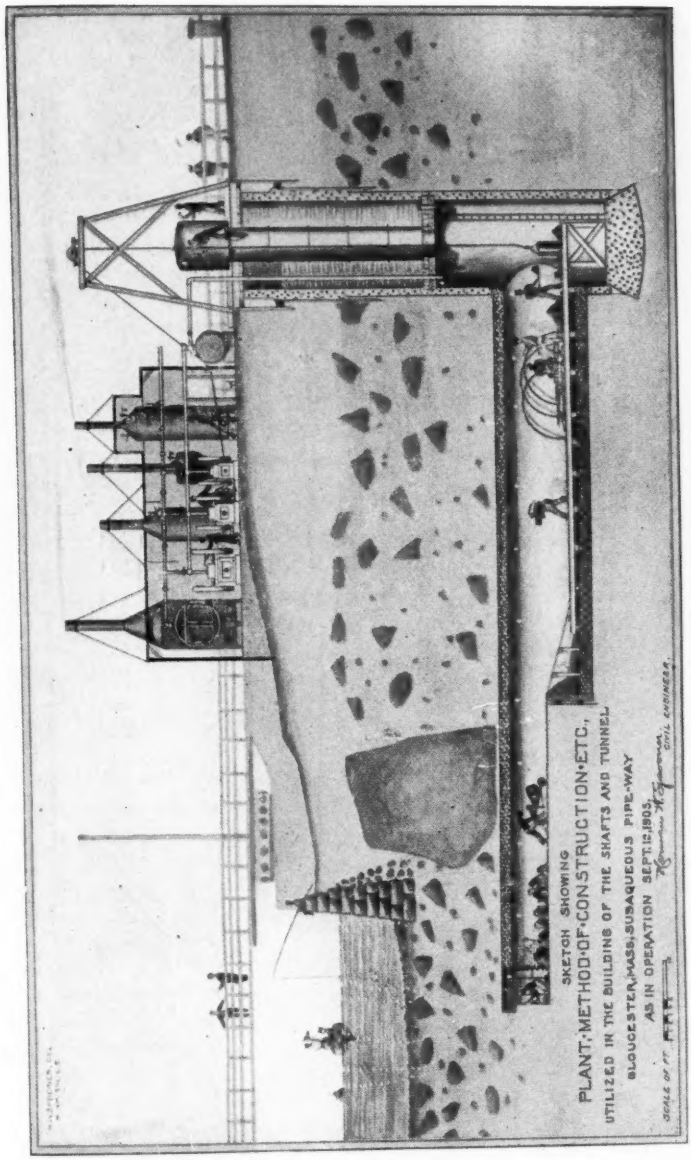
In order to increase the weight of the cylinder, hundreds of tons of pig-iron were placed upon the deck and walls in the endeavor to drive the cylinder down, but even under this added weight it still remained firm.

The sand used as a guide had shifted and the surrounding ground settled or slumped, carrying sheathing and channel-iron rings with it to such an extent that the head-house was unstable, a cavity extending nearly 10 ft. from the cylinder in all directions being open Heavy timbers were placed to span the hole and support the superstructure, these being held together with heavy chains.

It was decided at this time to drive a square set of sheathing outside the circular set originally placed, in an attempt to reach the channel-iron rings which were evidently jammed between the steel cylinder and the original sheathing; also to support the earth and prevent further caving. This was accomplished with considerable difficulty, it being found that the rings were in close contact with the cylinder, being much lower on one side of the cylinder than on the other; also that the heads of a few of the rivets used in making the joints of the cylinder had been entirely cut or scraped off as it had slid through the ring. Two rings were cut and the accessible portions removed, after which a boulder that had slid in and bound against the cylinder was broken and removed.

The work of excavating was recommenced beneath the cylinder after sections of the tube leading from the air-lock to the deck had been placed in position, and the cylinder was lowered after continued and discouraging efforts, as at no one time did it go down more than 20 ins.

Grade lines were drawn across the cylinder and preparations made for a final drop to the required grade. After the air pressure was removed the structure settled gradually, and


SKETCH SHOWING
PLANT·METHOD·OF·CONSTRUCTION·ETC.,
UTILIZED IN THE BUILDING OF THE SHAFTS AND TUNNEL
GLOUCESTER, MASS. SUBAQUEOUS PIPE-WAY
AS IN OPERATION SEPT. 12, 1903.

SKETCH SHOWING METHOD OF CONSTRUCTING SUB-AQUEOUS PIPEWAY AT GLOUCESTER, MASS.

when the desired point was reached, the air pressure was applied, but before there was sufficient pressure to counteract the weight, it had settled nearly 1 ft. below the line.

A space was immediately excavated below the cutting edge and poling boards placed in such a position as to allow for the placing of a concrete foundation of much larger diameter than the cylinder. The center of the excavation was dished to a depth of 8 ins. below the sides or ends of the poling boards, the material at the bottom and upon which the foundation was placed consisting of a mixture of coarse and fine hardpan gravel, in which, on account

of its firmness, it was difficult to make an impression with a pick.

A pressure of 17 lbs. was maintained while depositing the concrete for the foundation, placing the water-proofing, and until the whole mass had firmly set; the cavity around the shaft was filled and preparations made to extend the walls of the shaft upward.

The power plant upon this work July 1 consisted of three boilers, including the one used in connection with the hoisting engine, all being piped together and making a total of 50 h. p. to operate the hoisting engine and compressor. At this time it was decided to make a trial of the use of cement grout to harden the ground through which the tunnel was to be driven. A small 2-in. opening was made in the steel cylinder in the upper part of the eye which was 12 ft. in diameter, and which had been left free from concrete when the walls were formed. A thin mixture of grout was prepared and an attempt made to force it into the sand and gravel surrounding the steel casing, but after several attempts the idea was abandoned, as it seemed, under existing conditions, impracticable, it being only possible to solidify a very small section of the material directly surrounding the delivery point of the grout.

As the excavation was progressing at the different levels, corresponding to those through which the tunnel was to be driven, careful examination was made, with the result that when it was found that the solidification method was impracticable, recourse was had to the original method of using steel plates to support the earth above and upon the sides of the tunnel, while the masonry walls were placed with the aid of compressed air. A supplementary agreement was drawn and the contractor granted permission therein to use steel plates in place of ring timber, provided that the masonry walls, including the waterproofing and plaster, were constructed to a minimum thickness of 18 ins., a thickness equal to the proposed ring-timber and brick wall. This agreement was signed, plates ordered, and preparation made to cut out the eye. On July 3 a 50 h. p. upright boiler was added to the existing plant.

The work of cutting the steel cylinder progressed very slowly on account of the disadvantages under which the men labored, the positions necessarily occupied in holding and striking the points being decidedly awkward. After about 170 hours of continuous work by entire shifts with diamond points, a part of the upper portion of the eye was removed and it became evident that the channel-iron rings which were mentioned as having been used as a support for the original sheathing were to continue to disturb operations. Directly across the opening made in the side of the cylinder two of the rings were found twisted completely around each other, having been carried down at least 18 ft. while in close contact with the cylinder, thus causing the friction which retarded the settling of the cylinder. The sections of rings spanning the eye were cut out and the excavation continued.

On July 12 the need of an addition to the air compressor plant was noted, as the small machine delivering about 300 cu. ft. of air per minute seemed to be inadequate, the temperature in the heading rising to such a degree that an effort was made to cool the air with water and ice previous to sending it into work, and thus enable the men to work freely. The opening in the top of the eye was only 18 ins. in depth at this time, and on account of the loose nature of the ground the single compressor was working to its full capacity in order to maintain sufficient pressure to keep the water away from the breast.

A few small boulders were encountered in this first opening, which were removed without difficulty. For four full days, or eight shifts, the men labored in excessive heat, depending upon the one compressor, and succeeded in driving the arch of the tunnel a distance of four plates, or 4 ft. from the side of the vertical shaft. After two more rings were added it was decided to suspend operations and seal the heading with clay until another compressor could be installed, as it was decidedly dangerous to excavate further and depend on the one compressor then operating at its full capacity to maintain the required pressure.

On July 22 another compressor, originally designed for high-pressure, capable of delivering about 800 cu. ft. of air per minute was installed and in operation, working in conjunction with the other, and the work was again rushed forward.

The contractors at this time realized the necessity of still further increasing the plant by the addition of another boiler, as the three small boilers on the work were taxed nearly to their entire capacity. When the arch had

been driven a distance of 8 ft. the needle-beam, consisting of a timber 10 ft. in length, 12 ins. square, was placed in position, and the work of removing the lower half of the eye of the cylinder was commenced. The plate-joints and breast were completely covered with successive coatings of clay to hold the air, and even then it required the operations of both compressors at a high speed to maintain sufficient pressure, the thermometer registering 100 degrees in the heading and 90 degrees in the lock. The continuous labor (eleven hours) in humid compressed air at such high temperature began to affect the laborers and they were obliged to come out through the lock at intervals for change of air. On July 27 the brick masons laid the first section of invert and completed the arch and work around the eye on July 29, laboring in the intense heat nearly 45 hours to complete the section 6 ft. in length.

A temporary bulkhead of plank and bags of clay was placed in the invert at the end of the completed section, and the heading again opened. While this work had been progressing, another boiler (capacity 150 h. p.) had arrived, the entire plant being connected and in working order on August 3; the heading had now been extended a distance of 12 ft. through coarse gravel and boulders. At this time the larger of the two compressors became jammed and was out of commission for a few minutes, the whole load resting on the small compressor. During the strain this compressor turned 140 revolutions per minute, and although the pressure gradually dropped, the single engine held sufficient pressure until the defect was repaired and both were running.

It was evident to the writer that there was not sufficient duplication of plant upon the work, and in consequence he requested the contractors to still further add to the existing plant a compressor delivering at least 1,100 cu. ft. of air per minute. Under the conditions, it was unsafe to carry on operations in the heading, not only on account of the danger to the laborers, but also on account of the danger of loosening or the caving in of the breast and the loss of time in again recommencing operations.

The contractors kept in touch with the work, and knowing well the delicacy of the operation of driving the tunnel through the coarse gravel and stray boulders that might be encountered, suggested a decided change in the method of construction. Under the bed of the canal the roof of the tunnel was to be constructed within 11 ft. of low-water mark, the bed of the canal being practically dry at low tide. The amount of material above the work was deemed insufficient to hold sufficient pressure to allow for the construction of a full section of the tunnel wall; therefore it was decided that when the completed walls had been erected to within a safe distance of the canal, the upper half or arch should be driven and the arch wall completed under and as far as the westerly side of the canal to a point beneath the retaining wall.

The last addition to the plant consisted of a large low-pressure compressor, having a capacity of 1,100 cu. ft. per minute, and it was installed and in operation on Aug. 23. It was found that the difference in the temperature in the tunnel was about 20 degrees, being much lower than when the air was supplied by the small compressors; it was also noted that sufficient air could be supplied by the new engine with half speed on the second machine, allowing for repairs on the third or smallest engine.

At a point about 56 ft. from the easterly shaft a temporary bulkhead was erected, filling the bottom of the tunnel or invert to within a few inches of the spring line, composed of a brick wall 12 ins. in thickness and backed by clay puddle. This dam or bulkhead remained in place until the arch walls were completed under and beneath the western walls of the canal. During the construction of this arch about 9½ pounds of pressure was sufficient to carry on the work. When the tunnel had been driven to a point within 20 ft. of the easterly canal wall a slight leakage of air was noted in the waters passing through the canal. This disturbance continued to increase as the work was extended, and when it had progressed to a point directly beneath the canal, the air rushed up through the waters in such volume from the heading that the canal for its entire width and a distance of 50 ft. up and down stream resembled a boiling caldron, which was watched with much interest and speculation by large numbers of people from the bridge.

The work of driving the arch had progressed only a few feet when a boulder was uncovered in the roof extending across the heading for a distance of 5 ft. and hanging into the opening about 2 ft. A few light charges were fired in

small hand-holes made on the under side of the boulder, but no marked effect was made. Drilling and splitting was then commenced, and after nearly a week of continuous work the roof-plates were made secure beneath the stone, a sufficient amount of the boulder having been removed. Several small boulders were found, split, and removed from the heading, remaining in the completed tunnel until the air deck was removed, as they were too large to move through the lock.

During the progress of this part of the work the ground occupying the position of the invert remained undisturbed, the bench or ground below the spring line being covered with a layer of clay 6 ins. in thickness, having an overlayer of boards. It was quite a difficult task and required continuous watching to keep the pressure at an amount sufficient to keep the water from entering under and through the clay floor, and again not enough to lift the canal bottom and cause a blowout, it being necessary to watch the rise and fall of the tide and regulate the pressure according to its different levels.

During this part of the work the smallest error in air pressure could but result in severe monetary loss to the contractors and possibly the loss of the lives of the men employed in excavating the heading. The materials excavated were coarse sand and gravel, through which the air rushed freely when not retarded by the coating of clay applied from within, and was removed from its original position by small trowels. This gravel, after being dug out with the trowels and dropped on the bench, was shoveled into a single wheelbarrow and transferred to the shaft. Here it was again shoveled into a bucket to be lifted into the air lock. From the lock it was dumped into carts and hauled to the dump. Thus it will be understood that the gravel excavated was handled five different times before being finally dumped, making the expense heavy.

Several times during the perilous part of the work on the arch, the earth was driven upward by the air pressure or fell away, leaving a large aperture through which the air roared to the surface. During these periods the whole compressor plant was operated to its entire capacity; these voids were immediately filled with clay, bags, or any cloth or material which would stop the outrush of air, the miners knowing that were these voids not filled at once the pressure would relax and the waters from the canal and the harbor rush in. On September 21 the arch was completed to a point about 14 ft. from the western shaft and beneath the westerly side wall of the canal, and a solid brick bulkhead erected. This bulkhead was built within the completed arch and about 1 ft. back from the toothing, thus leaving sufficient brickwork for conection with that part of the tunnel which was to be built from the westerly shaft.

The first temporary brick bulkhead was now removed and the invert constructed, the connection between the arch and invert being made tight by splitting brick in form of a wedge and driving tight. This being neatly executed, the circular section was made complete to the terminus of the work to be accomplished from the east side. The bulkhead having been completed and braced by heavy raker timbers stepped into the brick invert, the air pressure was removed and the air tube and lock transferred and fastened in position in the west cylinder, the air and water supply pipes were suspended over the canal, the head-house placed in position, and the work of settling the western shaft commenced on October 6.

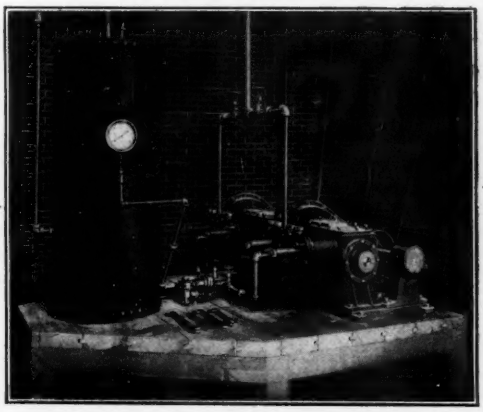
The west cylinder, having timber guides, settled rapidly, the cutting edge being kept in contact with the bottom, slipping down when the air pressure was slightly reduced; thus the trouble of the heaving of gravel, as was experienced in sinking the east shaft, was avoided, and on October 9, 12 ft. of progress downward had been accomplished. On October 13 the cylinder reached the required level and the concrete walls were extended upward toward the surface. The excavation was made and foundation placed similar to that in the east shaft, and the work of cutting out the eye of the tunnel in the steel cylinder commenced. The levels and lines were transferred through the deck and preparations made to excavate for the arch. This work was commenced on October 19 and six days thereafter the toothing of the completed section and bulkhead was met, and on October 30 the continuous walls of the tunnel were complete from the east to the west shaft. The work of calking, cement washing, and finishing was begun immediately after the bulkhead was removed, the fires were drawn in the larger boiler and it was removed. On November 4 the night shift was discharged, the work thereafter being carried on by one

gang during the day. Three days thereafter the air pressure was withdrawn, and the writer was gratified to note that there were very few damp spots throughout the entire length of the tunnel.

COMPRESSED AIR CLEANING TEXTILE MACHINERY

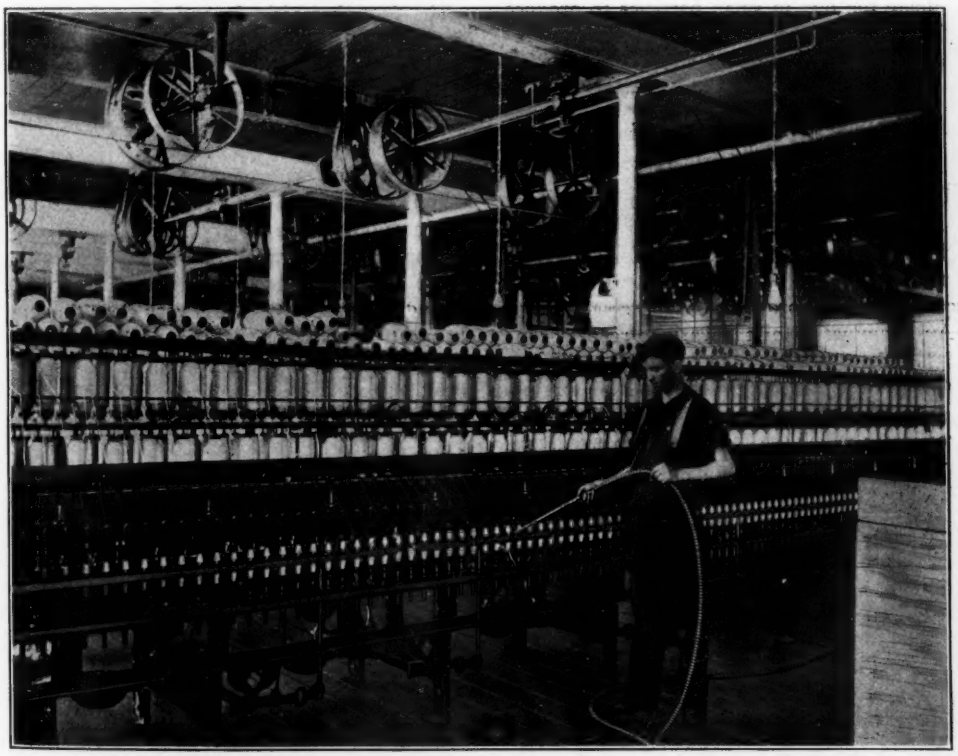
Compressed air is so handy, so efficient and economical for cleaning machinery, that the industrial establishment without a compressor plant even for this service alone is deficient in an important detail of successful operation. Especially in textile mills where the highly inflammable lint and dust accumulates on the machines and walls is the thorough and systematic removal of such material important, and no more efficient means has been found than a jet of compressed air.

The half-tone, Fig. 2., shows the cleaning of a spinning frame in a New England cotten factory. Although only one boy is seen, two boys work together, one on each side of the machine, so that when one side is being cleaned the dust will not settle on the other. Each frame as here shown has 256 spindles; it takes the boys seven minutes to clean one frame, and they clean seven frames an hour.



COMPRESSING PLANT FOR AIR JET.

Fig. 2 shows the special compressing plant



CLEANING SPINNING FRAMES WITH AIR JET.

for this service, built by the Westinghouse Air Brake Company. It comprises two belt driven compressors with automatic governor, air receiver and appurtenances. The compressors are the same in nearly all details as those furnished with the Westinghouse air brake equipments, being simple, compact, easily installed, requiring little attention and generally well adapted to the requirements of this service. By the use of the governor the operation of the compressors may be made entirely automatic.

The suction of the compressors is piped to the outside atmosphere where cool dry air is obtainable. The main compressed air pipe crosses the yard from the machine shop where the compressors are located, there being about 20 feet between the buildings, and in this space a cooling coil is installed for condensing all moisture possible, and a trap is placed in the line inside the factory, all excess of moisture being thus removed.

For textile mills about 40 lbs. air pressure is found to be most satisfactory. Air higher than this is likely to break the yarn or to disseminate the dirt in small particles to produce soiled spots. The use of higher pressures also increases the cost of compression.

HUMIDITY AND MINE EXPLOSIONS*

By Carl Scholtz.

During November and December, 1907, four serious mine explosions occurred in the Appalachian coal field, which resulted in the loss of nearly a thousand lives and caused an enormous damage to property.

An examination of the various reports concerning these accidents indicates that the explosions were caused by the ignition of gas or dust; they show the point of origin and the direction in which the force was expended, and give a detailed description of the damage done. Very little has been said as to what should be done to prevent these explosions, and the object of this paper is to give the result of several years' observation of conditions which I have noticed during 15 years' connection with coal mines in various fields of the United States.

*From a paper before the American Institute of Mining Engineers, Birmingham Meeting, October, 1908.

The striking features developed by these investigations are:

1. Explosions occur more frequently in the colder months of the year; the colder the winter the more frequent the explosions. If a certain district has extremly cold weather and other sections of the country are comparatively warm, the latter sections are freer from explosions.

2. Mining fields located in higher altitudes are more productive of explosions than those at lower elevations.

3. The hygrometric condition of the atmosphere has the greatest effect upon the cause of explosions.

Every practical mining man knows that the majority of explosions take place between November 1 and March 15. It is well to say here that there are many explosions of a minor character which result in no loss of life, or perhaps one single death only, of which but little is published in the daily or technical press. Every mine examiner instinctly feels danger when he enters the mine on a cold crisp morning.

The fact that altitude and general climatic conditions enter into mine explosions can very readily be verified by an examination of the weather reports showing the general climatic conditions which existed in the various localities when accidents happened.

The principal fields of mine explosions in the bituminous districts are Pennsylvania, the eastern portion of West Virginia, Alabama, Oklahoma, and Colorado; and since coals produced in these fields are high in volatile matter and low in moisture, it is very clear that the chemical composition of the coal has much to do with the generation of mine gases and coal dust.

In examining the records of explosions in West Virginia, it will be noted that most of them occur during unusually cold weather, and but few in the warm season when the trees are in full foliage. In Oklahoma the record indicates that the greatest number of explosions have followed an unusually dry season. It should be noted that this portion of the country is not densely timbered, and contains but limited bodies of flowing water. The same condition applies to Colorado to an even greater extent.

The two conditions above mentioned, when taken in connection with the visible results

which they create in the mine by the deposit of excess of moisture during the wet season, or when humidity is high, and the creation of dust during the winter months or the very dry season, undoubtedly lead us to believe that the hygrometric conditions of the ventilating currents have much to do with mine explosions; and since this is a matter which can be controlled without much expense, it is believed that the application of a vaporizing system in mines which are dusty and generate firedamp will prove, at least in part, a remedy.

After examining many text-books and reports, I noticed that very little reference is made to the hygrometric condition of the atmosphere in connection with mine explosions. Some of the more recent publications refer to the advisability of ascertaining the moisture in the air, but do not state the effect which humidity has, and how the required degree of saturation should be brought about. That humidity in a mine-ventilating current is desirable and necessary, is generally understood, and is emphasized by the recommendation usually made by mine inspectors that roadways be sprinkled with water in order to settle the dust. The adoption of appliances to settle the dust will prove the best safeguard against mine explosions.

Observations indicate that when the outside temperature ranges from 75 degrees to 90 degrees F., the inside temperature fluctuates from 72 degrees to 76 degrees F. In the winter, when the outside temperature ranges from 30 degrees to 55 degrees F., the inside temperature ranges from 60 degrees to 64 degrees F. In the summer, when the warm air-current enters the mine, the temperature falls, upon coming in contact with the cold ribs along the entries, and the excess vapor is deposited as sweat on the roof and the roadways, so that no dust exists. The mine, of course, becomes drier nearer the upcast, since a part of the humidity is absorbed by the freshly-mined coal. In the winter, when the inside temperature is higher than that of the air outside, the cold ventilating current, upon warming and expanding, absorbs all the moisture available. If there is no water available, the relative humidity in the air-current is very low. For the purpose of illustrating this more clearly, the following data, representing actual readings, will be of interest:

With an outside temperature of 80 degrees F. and relative humidity of 75 per cent., at a barometric pressure of 29.2 ins., a ventilation current of 75,000 cu. ft. per min. carries into a mine, invisibly suspended in the air, during a period of 24 hrs., 15,200 gals. of water. Upon cooling to a temperature of 75 degrees F. not only would the mine current be completely saturated, but there would be deposited in the mine nearly 1,000 gals. of water per day. In the winter, however, with a temperature of 32 degrees F. and a relative humidity of 95 per cent., upon entering the mine and warming to 62 degrees F., the relative humidity of the ventilating current is diminished to 33 per cent., unless an opportunity is given for the air-current to absorb more moisture from running water or other sources. In order to saturate completely this warmed air-current of 75,000 cu. ft. per minute, about 9,000 gals. of water per day are required. This is the reason why dust is generated in the winter in the better-ventilated mines, and the assumption is well borne out by the accident at the Monongah mines, which had a ventilating efficiency of the highest order. The more cold air forced through a mine in the winter, the drier will that mine become; the more air forced into a mine in the summer, the more mosture will be deposited along the intake entries, and where the roof is slate, the more difficulty will be experienced in keeping up the top. It is also well known that humidity in the air has an effect upon the ignition of gases, because the fine particles of water invisibly suspended in the atmosphere absorb much of the heat in combustion. For comparison, it may be said that an air-current of a temperature of 62 degrees F., fully saturated with moisture, requires approximately 7 per cent. more heat units (British thermal units) than dry air to reach a temperature of 1,213 degrees F., which is the point of ignition of firedamp.

A water-spraying system, consisting of a number of small sprays distributed over the first half of the distance which the air-current traverses will have the effect of preventing the formation of dust and moistening the gaseous mixture. The sprays should be placed near the roof, and discharge the water in the directions of the air-current. This arrangement will have an additional beneficial effect in mines generating much firedamp, the descending water spray serving to break up any stratification of gases that may exist in the entries.

The proper quantity of water to be vaporized will depend upon altitude, climatic conditions, and character of the coal. The only danger to be guarded against is the use of an excessive amount of water, which would result in cutting a slate roof; if coal or sand rock prevails, no limit need be established, because, with the lower temperature in the mines in this country, the danger which was pointed out by the British Colliery Commission, that excessive humidity injuriously affects the health of the miner, does not exist, the temperature of the English mines being from 90 degrees to 95 degrees F.

The installation of a spraying device of this character is very inexpensive and there is no cost of operation. A 1-in. supply pipe connected with the pump discharge in the shaft, with branches for some of the entries, is all that is necessary in addition to the spray boxes, which can be purchased at a very low cost (about $2 each). It is estimated that one spray box is sufficient for each 5,000 cu. ft. of air supplied per min. These spray boxes operate automatically as long as the pump is running, unless an independent pressure supply is furnished from a tank or other source. The pressure required to operate the sprays is from 12 to 20 lbs. per sq. in.

I recommend that mining engineers and coal operators, in fields subject to gas explosions, obtain, for their own information, a record for a year, taken once a week, both outside and at the point of upcast, to show the temperature and relative humidity, and from these results compute the amount of water which is carried into and taken out of the mine. It is predicted that the results will be astonishing to a great many.

Another comparison between the conditions in a mine in dry and in wet weather may be made by the operation of internal-combustion engines. The consumption of gasoline in the summer is much greater than in the winter in the same climate; in the warm weather the excess of humidity present in the mixture absorbs a certain amount of heat units before the vapor develops effective power; consequently, an automobile consumes more fuel in the summer than it does in the winter under the same conditions. A gaseous mixture containing dry air becomes explosive with a much smaller percentage of methane, and the higher the ratio of humidity in the mine and the ventilating current the less is the danger.

The following table shows the amount of water in 100,000 cu. ft. of air completely saturated and at various temperatures:

Water in 100,000 Cu. Ft. of Saturated Air.

Degs. F.	Lbs.	Gals.	Degs. F.	Lbs.	Gals.
32	31	3.7	65	97	11.6
35	34	4.1	70	114	13.7
40	41	4.9	75	134	16.1
45	49	5.8	80	156	18.7
50	59	7.1	85	182	21.8
55	70	8.4	90	212	25.4
60	82	9.8			

Example—how much water is contained in an air-current of 80,000 cu. ft., at 45 degrees F., 85 per cent. relative humidity?

(49 lbs. × 80,000 cu. ft.) ÷ (100,000 cu. ft. × 85 per cent.) = 46.1 lbs. per min. (× 1,440) = 66,384 lbs. or 7,960 gals. per 24 hrs.

If this current is warmed to 65 degrees the amount of moisture would represent 61 per cent. relative humidity. Under this latter condition dust will form readily.

SATURATED AIR AS A COOLING AGENT

By Arthur Pennell.

Whenever it is desired to liquefy steam or other condensable vapor, some cooling agent must be employed which has the ability to absorb the heat evolved by such condensation and act as a vehicle for its disposition by some natural means. Cold water, the most obvious agent for the purpose, is often unattainable or too expensive. Air, which is omnipresent in unlimited quantity, also possesses properties which render it an efficient cooling agent.

SOME PROPERTIES OF AIR.

Absolutely dry air does not exist in the lower strata of the atmosphere. It always carries, mechanically mixed with it, more or less water vapor. Air is said to be saturated with water vapor when a cubic foot thereof consists of a cubic foot of water vapor at the elasticity due to the temperature and a cubic foot of dry air whose elasticity is the difference between the barometric pressure and the elasticity of the water vapor. The humidity of such air is 100 per cent. The two mixed form one cubic foot of saturated air at barometric pressure.

Everybody must have witnessed a white fog in a valley on a bright summer morning. The

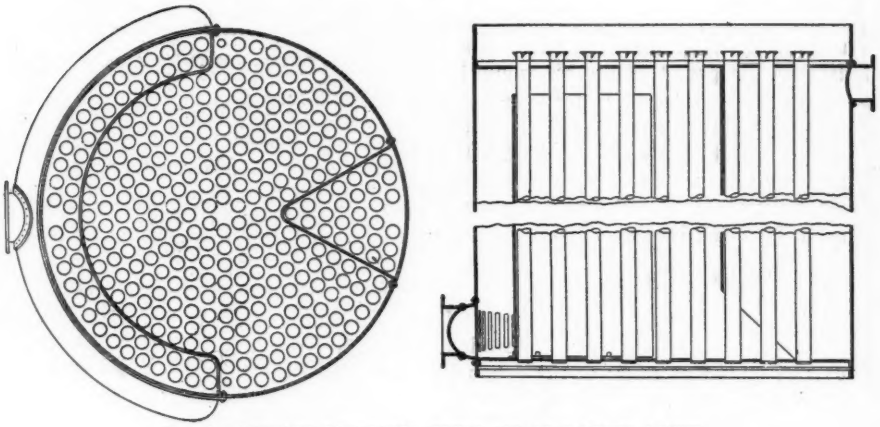


FIG. I.—SURFACE CONDENSER USING AIR AS COOLING AGENT.

air in the fog must have been completely saturated inasmuch as minute vesicles of liquid water were visibly floating therein. As the sun rose higher and higher, the fog gradually dissipated. Sufficient heat had arrived both to vaporize the liquid vesicles and warm the air sufficiently to be able to absorb it. If, at such moment, the shade temperature was 62 degrees Fahrenheit and the barometric pressure 29.92 inches of mercury, each cubic foot of such air would have weighed 0.0761 pound and consisted of a cubic foot of water vapor at an elasticity of 0.556 inch of mercury weighing 0.000881 pound, and a cubic foot of dry air at an elasticity of 29.92—0.556 inches of mercury, weighing 0.0747 pound. Further, each pound of dry air present would have carried 0.01179 pound of water vapor. By noon, we will assume, the shade temperature had risen to 82 degrees Fahrenheit. The air was no longer saturated but carried the same load of water vapor in a state of superheat. If such air had the opportunity of passing over a wet, hot surface, it would absorb water vapor at the ex-

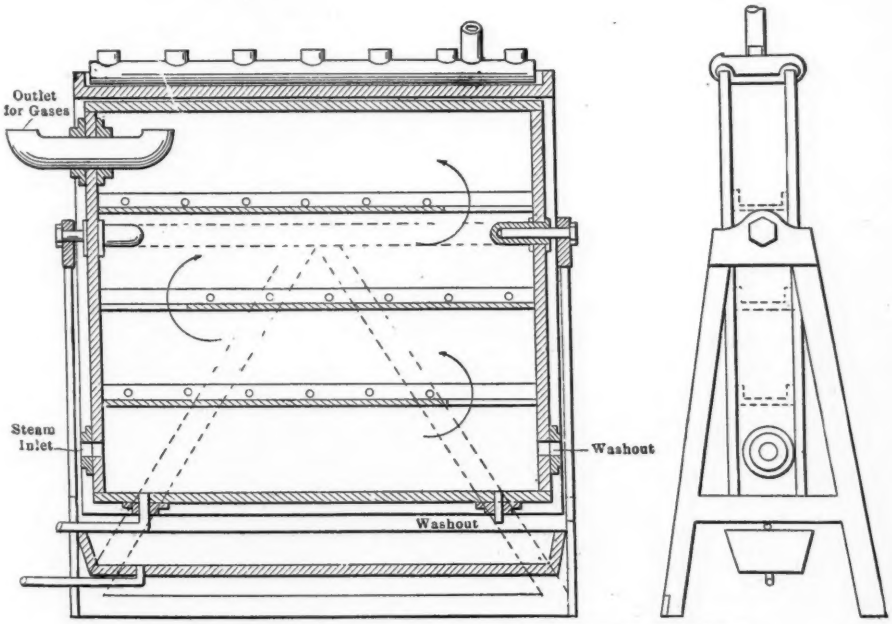


FIG. II.—SINGLE UNIT OF PENNELL FLASK-TYPE STEAM CONDENSER.

pense of the heat of the surface. Should it succeed in saturating itself with such water vapor at 82 degrees, the pound of dry air would be mixed with 0.02361 pound of water vapor and would have absorbed 0.01182 pound of water vapor from the hot, wet surface. A familiar practical example of the foregoing occurs whenever a freshly sprinkled street pavement is drying under a hot breeze.

SOME TEST DATA.

Fig. 1 shows sections of one of a pair of condensers using saturating air as cooling agent, erected on the premises of the Armour Packing Company, of Kansas City. They were designed to condense, at atmospheric pressure, the exhaust steam from a number of simple engines developing a total of about 1100 horsepower. As one of them, while clean, was able to perform the duty, and a compound engine was being installed, the second outfit was equipped to condense the steam from the compound engine. The results of a nine-hour test are given in the next column, this condenser operating upon a York cross-compound refrigerating engine, 30x58x48 inches, running at a speed of 45 revolutions per minute.

Assume water being pumped direct from the Kaw river at a temperature of 75 degrees Fahrenheit, a lift of 40 feet, and the condenser requiring 9.373 pounds of circulating water per pound of steam condensed. Five hundred indicated horse-power (6975 pounds steam) will require 65,376 pounds of circulating water per hour; or, 1,088.75 pounds per minute; lifting 1086 pounds per minute would require 1.32 horsepower; adding 50 per cent. for friction, 1.98 horsepower, which at 15 cents per horsepower for twenty-four hours, would cost 29.7 cents.

The elasticity of vapor at this condenser temperature, 123.7 degrees Fahrenheit, is 3.827 inches of mercury, which deducted from the average barometer reading for this day, 28.58 inches, shows the ideal vacuum would be 24.753 inches; however, this ideal is impossible to obtain by mechanical means. About 21¾ inches should be obtained under best conditions.

It will be noted that the total weight of steam, condensed at a temperature of 123.7 degrees Fahrenheit, was 71,550 pounds. The condensation was effected by the atmospheric vaporization of 499 cubic feet, or 31,150 pounds, of water. The weight of water atmospherically vaporized was only 43.5 per cent. of the weight of the steam condensed. This result will be corroborated by the result of another test made elsewhere, several years later, on another type of condenser.

Average steam pressure at engine, gage, lb	139.8
Average vacuum per engine, gage, in.	18.38
Average temperature in condenser, deg. F	123.7
Average temperature of circulating water, deg. F	116.4
Average temperature of city water, deg. F	52
Average temperature of outside air, deg, F	62
Average temperature of saturated air of condenser, deg. F	106
Average draft in stack of condenser, in.	0.1
Average humidity of outside air, per cent	67
Total amount of steam condensed, lb.	71,550
Average amount of steam condensed per minute, lb	132.5
Total amount of circulating water used, 16,700 cu.ft., or lb	1,032,060
Average amount used per minute, 233.17 gal., or lb	1911.22
Total amount of city water used, 499 cu.ft., or lb	31,150
Average amount used per minute 6.93 gal., or lb	57.7
Ratio of circulating water and steam condensed	1 to 14.42
Ratio of city water and steam condensed	1 to 0.435
Average horse power per hour on engine during trial, per indicator cards	569.74
Average weight of steam used, per I.H.P	13.95
Average horsepower required to run air pumps	10½
Average horsepower required to run circulating pump	3
Total amount of condensing surface, sq.ft	3900
Amount of steam condensed per sq.ft. surface, per hour, lb	2.038
Cost of city water for 9 hours, 3740 gal., at 2½ per M	9.25c
Cost of circulating condensing water for 9 hours (233.17 gal. per min.), 3 horsepower per hour, at 15c. per horsepower—24 hours, c	15.625
Total cost for 9 hours, for 569.74 horsepower, c	24.875
Cost of water for 500 indicated horsepower, for 24 hours, under existing conditions, c	58.2

RESULTS OF NINE-HOUR TEST.

The amount of steam condensed per square foot of surface per hour was 2.038 pounds, when the condensing temperature was 123.7 degrees, while the initial and final temperature of the circulating water was 116.4 degrees. This figures out 287.1 B.t.u. transmitted per square foot of surface per hour for 1 degree of difference. The surface was somewhat coated with scale. The draft, due to 50 feet of flue was 0.1 inch of water. Manifestly, to obtain the low condensing temperature necessary for high

vacua, artificial draft, capable of supplying three times the volume of air, would have to be installed.

A new field is now being opened for a suitable modification of this type of condenser in oil refineries, for condensing petroleum vapor. As these vapors arrive at temperatures ranging from below 100 degrees Fahrenheit to over 600 degrees, the facility of controlling the cooling agent is of considerable economic value.

Fig. 2 represents a flask type of condenser for steam at atmospheric pressure for use in ice plants. The steam enters near the bottom, follows the course indicated, condensing as it goes toward the outlet at the far end of the top bay, when the noncondensable gases escape into the air. The condensation water is led away from an outlet in the bottom. The circulating water is caused to flow in a thin sheet over the surface, thoroughly wetting it down, to be received in a collecting trough and thence into a catch can, from which the circulating pump returns it to the distributing system on the top.

Conditions were such that only 10-minute tests were practicable, the results of one of which is appended:

Time, Min.	Surface, Sq. Ft.	Condensed Water Entering Hot Well, Gal.	Decrease in Connecting, Can, Gal.	Temp. Circulating Water, Deg. F.	Temp. Issuing Gases, Deg. F.
10	24	6	3	183	150

It will be noted that the circulating water reached a temperature of 183 degrees, or 19 degrees below that of the condensing steam inside. In this case, the surface was new and absolutely clean. Calculation shows that 416.4 B.t.u. were transmitted per hour per square foot for each degree of difference. Further, the amount of water required to "make good" will be noted. The atmospheric vaporization was 50 per cent. of the amount of condensation water delivered. In this case the steam came direct from the boiler and was probably more nearly dry than in the other test. The amount of "make good" water varies with the weather conditions, probably ranging from 33 per cent. in zero weather to 66 per cent. in hot, dry summer weather.—*Power and the Engineer.*

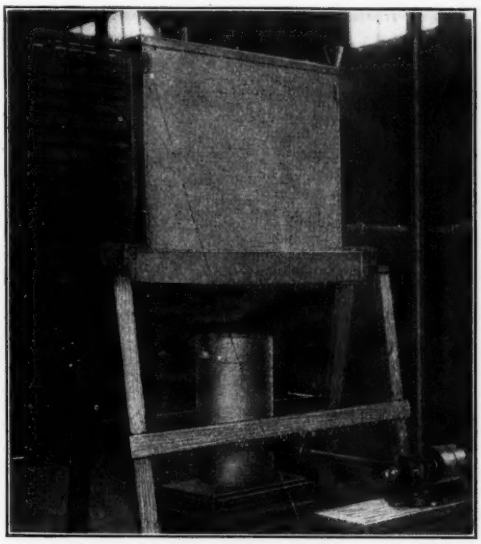


FIG. III.—AN ICE-PLANT INSTALLATION OF THE PENNELL CONDENSER.

HOMEMADE DESPATCH TUBES

When the inspectors have completed their examination at the inspection pit each man writes his report on the proper form and sends it by pneumatic despatch tube to the engine house office. By this means the reports covering the condition of the engine will reach the work distributor's desk almost as soon as the engine reaches the ash pit. The tube can easily be installed by any competent pipe fitter and is usually constructed of two-inch pipe laid in a box underground or carried on the ends of the ties. The fins should be smoothed off the inside of the pipe and a simple carrier can be made of an old air brake hose. When the reports are ready they are slipped into the carrier and the latter pushed into the open end of the tube. A hinged flap valve is then held against the tube and the air pressure turned on, a distance of several hundred feet requiring only a few seconds. As almost all of the larger engine houses are provided with air compressors, it is easy to secure the motive power needed by using a reducing valve set to a few pounds. The carriers as they come out of the tube strike against a spring buffer a foot or so away and drop into a basket. The man at the receiving end then signals to the other end by means of a bell or incandescent lamp and the air is shut off and the flap valve allowed to fall.

The usefulness and value of this simple and inexpensive tube system can hardly be appreciated by those who never used it. The condition of an engine is known to the engine house force within a few minutes after it reaches the inspection pit, and they know at once whether the engine can be marked up for a run and a crew called or whether it will require shop attention which may take several hours. The connection of inspection pits and pneumatic tubes will save their cost many times over at nine-tenths of the large engine terminals of the country.—*Pittsburg Railroad Club.*

FLOATING A HEAVY CAISSON

The Caisson for one of the piers of a bridge built some years ago across the Kaw river at Kansas City, Mo., was found to be too heavy to float in the shallow water near the shore if left in proper condition for sinkinng before being launched. The caisson was 22 ft. wide and 56 ft. long and the distance from the cutting edge to the top of the roof of the working chamber was 13½ ft. It contained about 10,000 cu. ft. of timber and about 20,000 lb. of metal in the shafts, cutting edge and bolts. With this weight the cutting edge was submerged between 10 and 11 ft., which was more than the depth of water near shore. A false floor of the usual construction was built in the working chamber beneath the lower row of horizontal struts, which were 1 ft. 10 in. above the cutting edge. Two-inch plank was used, and after the floor was finished the joints were carefully calked to exclude water from the working chamber. The caisson was then floated to place, the false floor removed and the caisson allowed to settle to the river bed.—*Engineering Record.*

[Compressed air at a pressure not exceeding 5 or 6 lbs. would have expelled all the air inside the caisson, and it would then have floated higher than with the false floor. In either case precautions would have been required to keep the caisson level.—Ed. C. A.]

Timber in a flooded mine, even after 20 years or more, will be found intact and temporarily unimpaired, but after exposure to the air it is speedily affected by decay.

AIR COMPRESSION UNDER DIFFICULTIES

The indicator cards here reproduced from *Power and The Engineer* will be found interesting. Figs. 1 and 2 are from a two-stage air compressor with air cylinders 28 and 17 inches respectively, and cross-compound Corliss steam cylinders 16 and 30 inch by 36 inch stroke. These cards were taken from the air cylinders when said to be operating under normal conditions. The cards are smaller than actual size, so that the scales must be disregarded.

Fig. 1, from the low pressure cylinder, suggests the remark that the intake line is unusually low. Although the clearance at the delivery end of the cylinder is not large the apparent total loss of cylinder capacity is about 14 per cent., and chiefly on account of the length of piston travel before the intake pressure rises to the atmosphere line. Some compressors show no loss at this end of the stroke, filling the cylinder right up to the atmospheric pressure before the compression stroke begins. In the cards as here shown the low pressure cylinder was compressing to 25 or 26 lbs., and the second cylinder was delivering the air at about 100 lbs.

The principal interest is in Fig. 3. Recently an accident to the low pressure steam element of the compressor put all that side, both steam and air, out of business for a time. As it was impossible to get along without air for any length of time, and still keep all parts of the plant in operation, the master mechanic decided to run the compressor on the high pressure side alone. What was done is described by Mr. Cederblom, Gary, Ind., as follows:

"The low-pressure connecting rod was taken off, both steam and exhaust valves taken out and the bonnets replaced; also, the positive-motion air-inlet valves and several of the poppet type of discharge valves on the first stage were taken out. This change allowed free exhaust of steam through the low-pressure steam cylinder, an air inlet, unrestricted as possible, through the low-pressure air cylinder, and an intercooler into the high-pressure cylinder.

"When the compressor was started again it took over an hour's running at full speed to get the line pressure up to 80 pounds; whereas, with both sides "hooked up" we could always get the required 100 pounds in 10 minutes. It soon became evident that unless the demand for air was lessened, the pressure could not be

raised above 80 pounds, which was about 25 pounds too low to operate some of the pumps and hoists.

"Afte speculating on the interesting question of how much air the compressor was turning out in its one-sided condition, we decided that the trouble lay in the intake resistance to the air, due to taking it at atmospheric pressure (only about 12.5 pounds here) through passages and inlet poppet valves designed for air at 25 pounds.

"The master mechanic then decided to get the required line pressure by running a 1-inch bleeder to the third stage of the four-stage high-pressure compressor alongside. The pressures of the different stages were 25, 115, 350 and 1000 pounds, and although the second stage would have suited the purpose better, the bleeder was connected to the third stage for reasons of despatch and convenience. A valve was placed in the bleeder to throttle the pressure and, the other end being connected to the discharge line of the crippled compressor, we soon had air enough for the demand. A couple of hours later when the quantity required was greatly reduced, the compressor was able to hold 105 pounds with the bleeder valve closed, and then, wishing to see exactly what was doing in that hard-working air cylinder, I put on the indicator and got the diagrams shown in Fig. 3.

"As expected, the admission line proved to be almost 7 pounds below atmospheric pressure, as compared with 1.5 pounds on the diagrams shown in Fig. 1. The diagrams also show that the piston actually traveled about one-fourth of the return stroke before getting the pressure back to the intake pressure, as shown at *A*, Fig. 3; and about two-thirds of the stroke before reaching 25 pounds, as shown at *B*, which would be the regular intake pressure under ordinary conditions. By comparing the volumes *V* discharged per stroke, Figs. 2 and 3, it can be readily seen how the capacity was reduced.

"Another interesting point is in comparing the compression curves under the different conditions. By plotting out the isothermal curve on Fig. 3, it will be seen that the actual curve gets much nearer to an adiabatic-compression curve than on Fig. 2, thus raising the mean effective pressure and hence the power required per unit of free air.

"While Fig. 3 represents an extreme case,

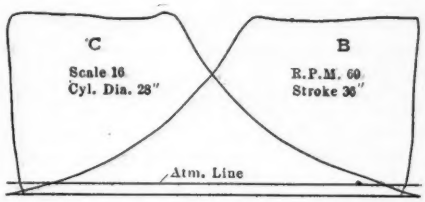


FIG. 1

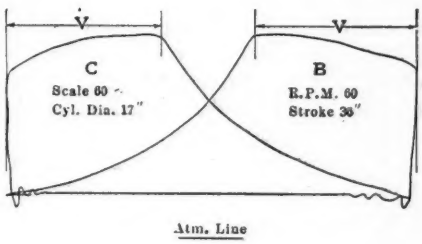


FIG. 2

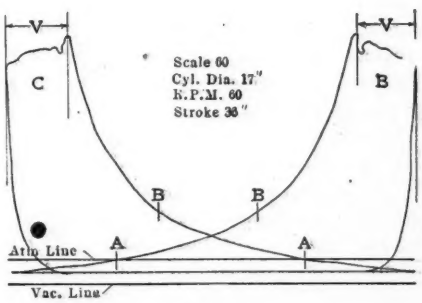


FIG. 3

it goes to show that too much attention cannot be given to air intakes and inlet valves. For example, in making new valve springs to replace broken ones, it is quite possible to make them much stronger than the old ones; or, in the case of positive-motion inlet valves, the point of admission might easily be too late, due to a slipped eccentric, lost motion in reach rods, etc., all of which would necessitate a greater degree of vacuum at the time of admission, and thus throw unnecessary work upon the compressor.

"A case in point is that of an engineer who extended his intake pipe a few hundred feet out into a bush, to get the screen away from the road dust; and the first fall afterward the screen became clogged with leaves to such an extent that it took a 17-inch vacuum to get anywhere near enough air for the demand.

"I have noticed that there seems to be very little practical information on air compression

in the bulk of engineers' journals, and if more attention were given to this important branch of our work, I am sure it would prove most acceptable to a large number of us who have compressors included in their plant. More light could easily be shed upon some phases of the work. For instance, I read not long ago the statement of an engineer to the effect that the only function of a receiver on an air line was the same as that of an air chamber on the discharge of a pump. I have always thought two of the most important reasons for a receiver being installed was to provide a place in which to *cool* the air, thus separating most of the contained moisture and allowing it to be drawn off; also, to provide a storage place, thus tending to prevent sudden reductions of pressure."

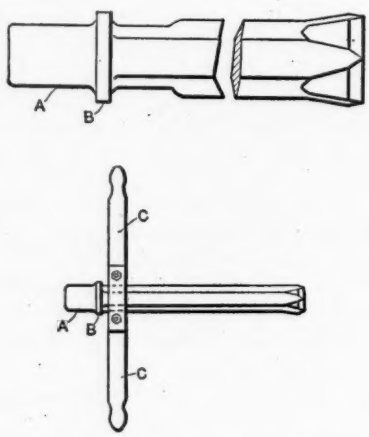
[The most unaccountable detail of the above narrative is that they took out only "several" of the discharge valves where the intake air was temporarily to pass, instead of taking out every one of them. This "several" may partially account for the very low intake line in Fig. 3.—Ed. C. A.]

PNEUMATIC WALNUT HARVESTING

The growing of English walnuts is now one of the established and profitable industries of California. One of the chief expenses involved hitherto has been the cost of gathering. A large portion of this expense is now done away with by the pneumatic walnut picker, the invention of an actual walnut grower, Mr. L. L. Sidwell, Pico Station, near Los Angeles. This walnut picker is mounted on a truck propelled through the orchards by a gasolene engine, the same engine driving the suction fan, the operation of nut gathering being similar to that of the now familiar vacuum cleaner. The nuts are not picked from the trees but gathered from the ground. The exhausting ducts have fan shaped mouths near the ground which lead to a large drum on the truck. These ducts spreading in front of the truck 8 or 10 feet wide suck up everything loose which comes in their way and convey it to the drum. Here the clods, twigs and rotten nuts are separated from the perfect nuts, the latter being poured into sacks. One man looks after all of the gathering and bagging operation and another man does the driving and steering. The first year's use of the machine shows a substantial reduction in the cost of nut harvesting.

INTERESTING USES OF THE PNEUMATIC RIVETING HAMMER

The writer had occasion to set a bed-plate on an old concrete foundation and the thought of drilling eight 2½-inch anchor bolt holes about 3 feet deep, by the old-fashioned method of sledge-hammer and stone drill, set his mind to work. The outcome was the making of a stone drill such as shown in the accompanying engraving. The shank *A* was turned to suit a pneumatic riveting hammer, and hardened. Two handles *C* were also provided and bolted under the collar *B*, as shown. It required two men to operate the drill, one to run the hammer while the other two turned the drill back and forth about a quarter of a

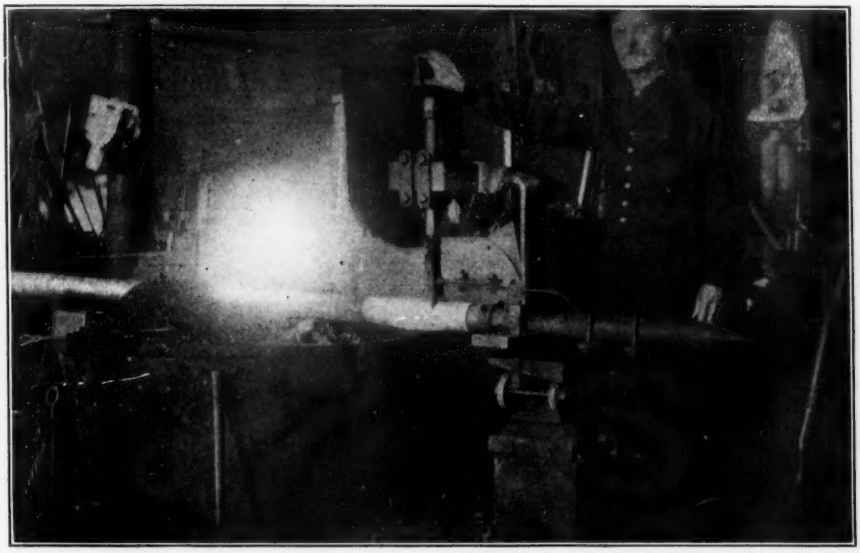


turn. The result was that the holes were drilled in less than three hours, which is only a fraction of the time usually required for the same work by the old method.

Another interesting use of the pneumatic riveting hammer, is to drive out fitted bolts that have become tight by rust or other causes. The instance in this line to which the writer refers was the removal of connecting-rod strap bolts on a small locomotive. These bolts were driven in from the top, and when it was necessary to take them out it was impossible to move them, and as a fair blow could not be given with a sledge, this method was abandoned. A 10-ton hydraulic jack was then tried, and while it would lift one side of the engine, the bolts would not stir. The pneumatic hammer with the ordinary button-set in it was next applied, and the result was that the bolts were removed in less than a minute each.—*Machinery.*

WELDING BOILER TUBES WITH A PNEUMATIC HAMMER

The half-tone herewith, which, by the way, is from an amateur's postal card photo, tells very clearly and completely how a pneumatic hammer or riveter is used in welding 3 in. boiler tubes in the blacksmith shop of the Homestake Mine, South Dakota. In the welding of boiler tubes all depends on the rapidity of the blows as the metal cools so quickly, and where hand hammering is employed it has been the practice to heat the mandrel to nearly a white heat, but with the pneumatic hammer used as here shown this precaution is not necessary.



WELDING BOILER TUBES WITH PNEUMATIC HAMMER.

The apparatus here shown is, of course, homemade except that a standard pneumatic riveter is used. As will be seen, the mandrel, upon which the tube to be welded slips easily, is clamped upon the anvil exactly in line with the tube as it lies in the fire. The swage is held by a flat spring, clamped to the rear of mandrel, just high enough to clear the tubes. The hammer is held in exact position by a standard which is clamped to the side of the anvil. When the tube is at just the right welding heat it is shoved forward onto the mandrel, the operator manipulating the hammer valve to shower the blows upon the swage while a man at the other end keeps the tube turning.

"COAL DUST AND MINE EXPLOSIONS"

In our issue for January at page 5147 appeared an article with the above title by Mr. Wm. N. Page, President of the West Virginia Mining Association. This was an open letter to the West Virginia Mine Managers, and it first appeared in the columns of *Coal.* The positions and conclusions of Mr. Page are, it will be seen, quite vigorously controverted in the following letter, which also was printed in *Coal.* The writer says:

Major Page starts out with the affirmation that "Dust as dust is not explosive." It would be waste of time to adduce proofs to disprove such a statement; one might just as well say that powder as powder is not explosive, gun cotton as gun cotton is not explosive, and so on ad infinitum. Coal dust does explode. He says a chemical alteration is essential to an explosion. Is it not true that chemical alterations, re-actions and combinations, are essential to all explosions of any nature?

Let us stop discussing the obvious, and acknowledge the fact that coal dust is not only an explosive, but the most deadly and dangerous known in our mines. What does it matter whether it is caused like an explosion of flour-dust, by an infinitely rapid combustion, or by as equally rapid distillation of explosive gases? The result is the same.

I agree with the writer that currents of high velocities are dangerous because of the large amounts of dust they carry in suspension; but the danger can be very much reduced by proper splitting of the current, thus reducing the velocity and volume. We must not lose sight of the fact that explosions do not originate in high-velocity currents; they simply serve as a medium to exaggerate the explosion, the primal explosion occurs at the face.

The trouble with most writers and investigators along this line is that they get away from the vitally important point, viz.: the origin of the explosion, which, in forty-nine cases out of fifty, is in the face where the air current is so feeble that it will scarcely move the vanes of the anemometer. Often the miner has a hole drilled, loaded and tamped before the machine-runner has finished cutting his place; as soon as the machine is moved out, with all the cuttings unremoved and before the dust has had time to settle, the shot is fired. Should it be a blown-out shot, and an explosion of dust occur, it is likely to be projected into the entry and the explosion become general, limited by the amount of dust held in suspension or by the amount of oxygen. Is it not plain to every sensible miner that the face of the rooms and entries is where the greatest precautions should be taken? If explosions are prevented there, there is little danger of explosions in the entries unless gas is allowed to back into them from old workings, which would be culpable neglect and criminal carelessness.

Explosions are nearly always caused by blown-out shots and consequent ignition of coal-dust, fire-damp or a mixture of both. The rigid observance of a few simple rules would reduce explosions to the vanishing point so far as the face is concerned. Before blasting, load out all machine cuttings, thoroughly spray the roof, sides and floor of the place to be blasted thirty or forty feet back from the face; let all shots be fired by experienced men, whose duty it shall be to see that the above is carried out, that the hole is properly drilled and that the place is free from fire damp. Do this, and explosions will seldom occur.

I am a thorough believer in the tendency of humid atmospheric conditions to lessen the danger of coal-dust explosions; the frequency of dust explosions when atmospheric conditions are the reverse of humid is to me a very convincing proof. For six, seven or eight months in the year humid atmospheric conditions prevail. It is proposed to bring about these conditions by artificial means in periods when they do not obtain naturally; but if this would increase the death rate to such a fearful extent, as Major Page asserts, it would be better to extract artificially the moisture from the air during the warm months before it enters the mines, allowing it to enter perfectly dry and suck up the natural moisture of the mine.

Some startling statements regarding the effect that water held in suspension has on the roof are made in this letter. While I do not for an instant dispute that currents of high velocities, surcharged by moisture, have a deteriorating effect on slate or soapstone roof, I do deny the statement that it plays any important part in accidents caused by falls of coal and slate, and will prove it to the satisfaction of every unbiased man acquainted with coal mining. Here are a few extracts from the letter I would ask the reader to go over in full:

"Water will not only affect the health of the miner, but it is the indirect cause of every death from roof falls."

"Sixty-six per cent. of all underground fatalities are attributable to falls of roof and coal, and only 34 per cent. to all other causes." He assumes that five per cent. of the deaths are due to coal-dust explosions. "It would seem, therefore, that the water remedy proposed in efforts to save five lives is now the death portion of 66, and any increase of water in the mines must necessarily add to roof fatalities." He then goes on to state that in West Virginia 90 per cent. of the roof is composed of slate or fire-clay, and that these substances disintegrate very rapidly when exposed to the atmosphere, and the more water introduced either by sprinkling or saturation of the air the more deadly will be the consequences.

Quoting again from the letter, he says, "We had a single phase danger with fire-damp, a two-phase danger with dust, and we will have a three-phase danger with water more deadly than the other phases combined." That these statements have no foundation in fact, the following will prove. For at least seven months in the year the general atmospheric conditions are humid, and nature in this way sends bountiful supplies of water into the mines. I ask: does death exact a greater toll by falls of roof

during the humid months than in the dry months? Not that anyone has ever noticed, and the reason is plain; it is because 95 per cent. of all injuries and deaths by falls of coal and roof take place immediately in the face, where there is no current, where neither the roof nor the coal has been exposed to the atmosphere, where humid or dry atmosphere has no more to do with falls of roof than I had to do with building the walls of Babylon.

It is the roofs of the entries which are exposed to the deteriorating effects of high velocity currents, especially the main entries. How seldom do we hear of a man being hurt or killed by a fall of rock in an entry? The secret of that is because the mine management is responsible for the safety of the men in the entries, and where poor roof conditions prevail they are subject to rigid daily inspections and all loose rock taken down or properly timbered. If the mine management were equally responsible for the safety of men in the face, there would soon be an appreciable dimunition of accidents there. It is looked upon as a disgrace to have men injured by falls of roof in an entry; every mine manager knows that. I venture the assertion that more men were killed by explosions last year in the States of Pennsylvania and West Virginia than have been killed by falls of roof in the entries of all the mines in both States in 50 years. I assert, again, the trouble and the slaughter is at the face, where water held in suspension plays absolutely no part in it. Here the chief factors are carelessness and ignorance.

Believing then, as I do, with so many eminent mining men in the efficacy of humid atmospheric conditions for the prevention of dust explosions, I would urge upon mine managers everywhere to adopt measures to bring about these conditions when they are not naturally present. Humidity does not affect the health of men in low temperatures; in such temperatures as prevail in our mines no deleterious effects have ever been noticed from the cause.

Major Page says, in his closing paragraph: "In our efforts to protect life and property we must look to the falling leaves as well as to the burning bush, and the men who die, one by one, under roof falls are as much entitled to protection as those who lose their lives in spectacular disaster." I thoroughly agree that we ought to protect the men as much as possible from falling roof; but by affording them a protection which is no protection, inasmuch as it has nothing to do with the falling roof where it kills, we are in grave danger of bringing about more of those tragic, spectacular disasters; which, God forbid!

So far as Major Page's letter is concerned, nothing is suggested to prevent these falling leaves. In my opinion, deaths and injuries can be reduced very materially by dividing the mines into sections of suitable size and appointing experienced men to each section, whose sole duty it shall be to look after the safety of the men; the section to be of such size that he can visit each working place twice each day; see that each place is properly timbered, and, if not, to stay there until the necessary timbering is done, and assist and instruct the men in every way. In a word, to make him responsible for the safety of the men under his charge. In the north of England, where I worked in the mines for many years, this system is in force at all the collieries, and accidents from falling roof or coal are very infrequent.

If they find it necessary to do this in England, where the men are all skilled miners and of comparatively high intelligence, all speaking a common language, how much more do we need a similar system here, where most of the miners are inexperienced, unskilled, ignorant, and mostly speak in an uncommon tongue?

Yours truly,

J. L. Dixon, E. M.

Pittsburgh, Pa.

EDISON'S WAY

The following is from a "talk" by W. S. Andrews before the Schenectady Section of the A. T. E. E.:

Word came to Edison in New York that the Cumberland people where burning out armatures rapidly. I made my appearance at the station in the evening and was met by a colored man, the engineer. I asked him if he were the only attendant, and if he attended the boilers, engines, machines, etc. He said "Yes, sah; I'm a hustler!" I asked him if he had been burning out armatures lately, and told him that I had come from New York to give him advice. I then asked him how he knew when the dynamos were

carrying too much current. He said that some one had told him that when the wires were carrying too much electricity they would get hot. He therefore felt of the wires occasionally, and if he found one getting hotter than the others, he would put in a little more resistance and cool it down. As far as I know, this is the first record we have of a "hot wire" ammeter.

I went back and reported to Edison. Edison said, "We have got to get up an ammeter." We set to work and made some in about a week or so. We got up the old Edison pendulum ammeter, and the first sample of this device was shown to Edison at the machine works. He said it was pretty good, but that we needed something rough. "Have six made up. When you examine and test them in the testing room, have them packed and then call me. I do not care to see them until packed and ready for shipment." When this was done, he was notified and came in. Edison said, "Put them on the table. Now, then, get up on the table and kick em'off; if they won't stand this, they will never reach Cumberland in operating condition." They were kicked off the table as hard as the fellow could kick them, and sent spinning over the floor. Edison then said: "Now I will look at them." Then after a careful examination, they were approved for shipment. It is needless to say there were no jewel bearings in the instruments at that time.

PRESERVING EGGS

An interesting method of preserving eggs by means of desiccation was lately put into successful operation at Sydney, New South Wales. Eggs freed from their shells are dried at the relatively low temperature of 130 deg. Fahr., in containers kept constantly at this temperature and from which the air has been exhausted. When thoroughly dried and reduced to a coarse powder the egg material can be preserved for an indefinite period in ordinary packages, if kept in a dry place. The eggs are "reconstituted" by the simple addition of water to the dry powder, the resultant mass being quite indistinguishable from newly beaten-up eggs. There is no alteration in the chemical composition, and purity, ease of digestion flavor, etc., are said to be unaffected by the operations.

COMPRESSED AIR PIPE CAPACITIES AND VELOCITIES

The following table we reproduce from a paper by Mr. E. J. Laschinger before the Transvall Institution of Mining Engineers. As it is generally understood that velocity of 20 feet per second in the mains, is preferable to anything higher, it will be seen that these figures begin near where it would be better to end. They, however, are probably closely applicable to current South African practice.

Nominal Size of Pipe.	Actual Internal Dia. Inches.	Surface Mains.		Shaft Mains.		Distributing Pipes.	
		No. of Drills.	Mean Velocity Ft. Sec.	No. of Drills.	Mean Velocity. Ft. Sec.	No. of Drills.	Mean Velocity. Ft. Sec.
1	1.05	.46	19.1	.51	21.1	.64	26.6
1¼	1.38	.85	20.5	.94	22.6	1.18	28.4
1½	1.61	1.21	21.3	1.33	23.5	1.67	29.6
2	2.07	2.12	22.7	2.34	25.0	2.94	31.5
2½	2.47	3.16	23.7	3.48	26.1	4.37	32.9
3	3.07	5.15	25.0	5.17	27.6	7.14	34.7
3½	3.55	7.15	26.0	7.86	28.6	9.91	36.0
4	4.03	9.5	26.8	10.5	29.5	13.2	37.2
4½	4.51	12.2	27.5	13.5	30.3	17.0	38.2
5	5.05	15.8	28.4	17.4	31.2	21.9	39.4
6	6.07	23.8	29.7	26.3	32.7	33.1	41.1
7	7.02	33.1	30.8	36.5	33.9	45.9	42.7
8	7.98	44.2	31.8	48.6	35.0	61.3	44.1
9	8.94	57.1	32.7	62.8	36.1	79.2	45.3
10	10.02	73.8	33.7	81.	37.1	102.	46.7
12	12.	111.	35.2	122.	38.8		
14	14.	157.	36.6	172.	40.3		
15	15.	183.	37.2	201.	41.0		
16	16.	212.	37.8	233.	41.0		
18	18.	276.	39.0	303.	42.9		
20	20.	349.	40.0	385.	44.0		

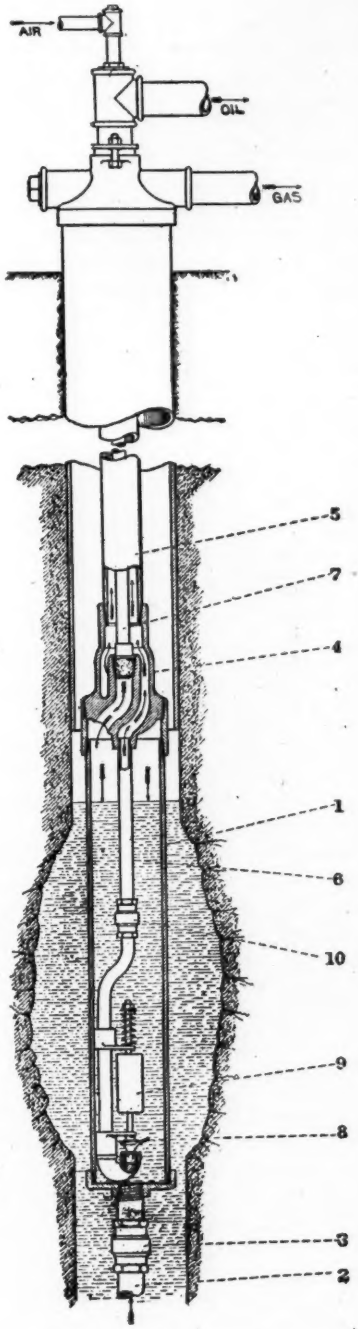
FLOWING OIL WELLS BY COMPRESSED AIR

Compressed air is being used very successfully in the flowing of oil wells on the farm of Mr. John W. Waitz near Oil City, Pa. One hundred wells are thus equipped and they yield a daily average of 200 barrels. The average depth of the wells is 800 feet, and the air pressure required is somewhat more than 400 pounds per square inch. The equipment of the wells will be readily understood by a reference to the accompanying engraving.

An oil receiver 1 is located in close proximity to the bottom of the well, presumably in the "shot hole," in the oil-producing stratum; into this receiver oil flows by gravity through the inlet pipe 2, which is provided with a check valve 3. The receiver is attached at its upper end to the by-pass 4, which in turn is attached to the tubing 5. An oil-delivery pipe 6 extends from the by-pass down into close proximity to the bottom of the oil receiver. An air-inlet 7, which is provided upon its lower end with a suitable packer, seats firmly in the upper end of the by-pass. The receiver 1 is composed preferably of 4¼-inch casing, and varies in length from 60 to 200 feet, depending upon the capacity or production of the well.

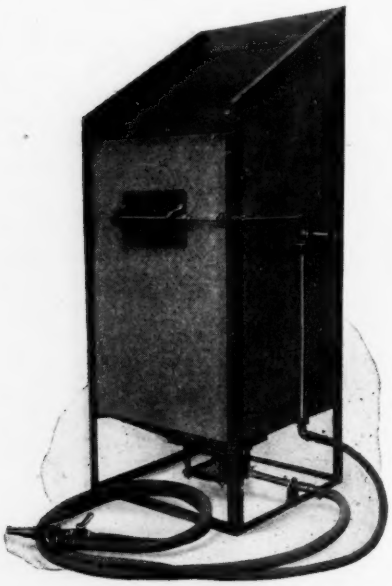
When the well is to be flowed, air is admitted to the upper portion of the receiver and, acting upon the surface of the oil, forces it downward into and through the delivery pipe 6, into the tubing 5, thence to the surface into a receiving tank or any suitable receptacle. Pipe 6 is provided at its lower end with an automatic valve. To the stem of disk 8 of this valve is attached a float 9, the weight of which is nearly balanced by a spring; when the float is submerged in fluid it is buoyed up and the valve-disk is held up from its seat. When the oil is forced from the receiver, the float lowers and causes the disk to seat, thus preventing the entry of air into pipe 6. A check valve 10 prevents the return of oil from the pipe 6, or tubing 5, into the receiver, so that said pipe and tubing always stand full of oil. The number of times that wells are flowed daily, depends upon the amount of oil they produce.

One of the valuable features is the "compounding" of the air. This operation consists in utilizing the air more than once. The air is turned into well No. 1, and when this well ceases to flow, a pressure gage upon the air



COMPRESSED AIR IN OIL WELL.

pipe leading to it will show a pressure of say 400 pounds. Communication is now closed between the air pipe of well No. 1 and the air compressor or air receiver, and the air pipe leading to well No. 2 is placed in communication with the air pipe leading to well No. 1; the air now flows from well No. 1 to well No. 2 until the air pressure in the two wells equalizes, and when the pressure gages show such equalization of pressure, communication between the air-pipes of the two wells is closed and the remaining air in well No. 1—which is at 200 pounds pressure—is taken back into the air compressor. Receiver or full pressure is then turned into well No. 2 and it is flowed in the same manner as No. 1.—*Scientific American.*



NOVEL SAND BLAST OUTFIT

The half-tone shows a sand blast outfit brought out by The Curtis & Co. Mfg. Co., St. Louis, which shows a radical departure in design and operation. The sand reservoir or tank is open at the top, but is covered with a screen of such mesh as to allow the dust and sand not too large to fall through, while pieces of castings or other foreign material roll down the incline and are rejected. Before the sand has a chance to drop into the tank the dust is separated from it by means of a small air jet, so that only sand itself and of the right size enters the hopper. In the conical bottom of the tank is an opening, about hand-hole size, and under this is a plate suspended by four studs. The sand drops freely through the hole onto the plate, forming a conical pile which as it increases stops the hole and prevents overflow. The sand hose and the air hose are separate, so that the sand is not in contact with the air under pressure, and if the air carries moisture the sand is not dampened or clogged by it. The blast of air through the nozzle creates a partial vacuum in the sand hose, and the sand is thus drawn by suction from the pile under the tank, the supply of sand being kept up automatically. The operator has only to control the air, which is done by a handy valve right at the nozzle. The machine can be filled without stopping or interfering with the sand blasting operation. If the sand hose becomes choked it can be cleaned at once by pressing the nozzle against the floor for a few seconds; only a cheap grade of hose is required for the sand hose. The air hose must of course be strong enough for the pressure.

LIQUID AIR IN THE MINE

The following is from the report of a lecture by W. W. Tunnicliffe at Ashby-de-la Zonche, Eng., on the Chemistry of Mine Gases:

The lecturer commenced with a most interesting exposition of liquid air. Amongst other experiments dry felt was saturated with liquid air, but when touched with a flame violent combustion was caused. Similar effects were produced with a roll of cloth, bound with wire and suspended for a time in the liquid. The explosive violence with which it burns, said Mr. Tunnicliffe, suggest the use of liquid air in blasting operations. He mentioned that liquid oxygen is now easily produced, and will probably be in use in the rescue apparatus of the future. Under ordinary circumstances half-a-pint of oxygen was needed every minute by a man, but under excessive work the need rose to nearly three pints per minute. In most of the rescue apparatus the oxygen supply was limited to three hours, but a pint of liquid oxygen would yield 800 pints of the gas at ordinary pressure, and would, therefore, last very much longer.

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NAVARRO

One cannot run over the briefest sketch of the life of José F. de Navarro, who died at his home in New York on Feb. 3rd, eighty-six years old, without realizing that he was an exceptional man, a man of initiative and of large achievement, who successfully inaugurated or established a number of the large world-moving enterprises of modern times. These several undertakings of his were quite unrelated and showed a vast reach of interest and ability. We must believe, however, that his most far reaching and enduring work was in the aid and push he gave to the development of the rock drill.

Mr. Navarro in 1904 prepared for private circulation a brief record, scarcely an autobiography, of his varied career. He was born in Barcelona, Spain, of one of the grandee families, his father dying in his infancy. He never became an American citizen. He graduated as a mid-shipman at the Spanish Royal Naval Academy when fifteen years old, and then went to live with his uncle at Havana, Cuba. His uncle had a large machine works and foundry, and here in the next year or so the young man gained considerable knowledge of shop operations. Serious disagreements caused a separation, and young Navarro then went to Philadelphia where he had discouraging experiences, acting among other things as an instructor in a Jesuit college for two or three years, during which time he privately studied the text books of the Rensselaer Polytechnic Institute of Troy, N. Y. Returning to Cuba he bought land on credit which he sold at a good profit and also realized $5,000 on a patent for a spark arrester. He enumerates in his life work eight business enterprises, the first being founded on his twenty-first birthday, and three of them being commercial in character, although in connection with the third he was engaged in the manufacture of water meters for the city of New York. "With the experience acquired in manufacturing the water meter," he says, "Sergeant and Cullingworth, my two capable and honest foremen and myself formed a company for jobbing purposes in the machinery line." This brought things in good shape for his fourth business enterprise. "We succeeded in picking up the whole of the capital stock of the Ingersoll Rock Drill Company, a broken down concern. After perfect-

ing their defective machines, we made an immense success." The embarrassments entailed by a later enterprise compelled Mr. Navarro to sell out, but he received a check for $540,000 for the stock originally valued at $45,000. The fifth Navarro enterprise was the Metropolitan Elevated Railway of New York. Of this he says: "I was certainly the initiator of the great work, the prime mover, the engineer minus the parchment." The sixth enterprise was the building of the Navarro apartment houses, Central Park South, which cost $6,000,000. This was a "tragic experience," and a financial failure, but the buildings were suggestive and provocative of a vast succession of edifices whose builders have profited immensely by the lessons afforded. The seventh enterprise was the manufacture of cement upon a large scale, and the last had to do with a coal pulverizing stoker. Mr. Navarro's summing up of his career is highly suggestive. He says:

"Thus I have worked for the last sixty-six years, ending moderately successful, but not in proportion to my efforts and the magnitude and possibilities of some of my undertakings; due partly to stormy times, partly to misfortune, partly to mistakes, partly to revenge, but principally to *my absolute isolation.* Battling all the time single-handed, without any interested working partner to talk to, to consult with, to be checked by, and to help me in the noble work of human progress, I have not realized this mistake until too late."

HIGH AND LOW AIR PRESSURE FOR SAND BLASTS

Editor Compressed Air:

Referring to the article, "High and Low Air Pressure for Sand Blast," which appeared in your January issue at page 5137, I beg to say that some of the statements are incorrect. For instance: it requires approximately 19 horse power to compress 100 cu. ft. of free air per minute to 80 lbs., with single stage compression, and about 9.5 horse power to compress the same volume to 20 lbs., and not 15.92 and 6.28, respectively, as stated in the article. [The latter are the correct *theoretical* figures, Ed. C. A.] According to the article, a low pressure blast with a ⅜ in. sand nozzle requires 69 cu. ft. of free air per minute, while a high pressure machine according to the table in "The Foundry" from which the article in question was taken by you, requires 191 cu. ft. free air per minute at 80 lb. pressure with a ⅜ in. sand nozzle. Now, the writer happens to have positive information, obtained from actual tests with one of the latest sand blasts, that this blast, due to its construction, actually used 77 cu. ft. of free air per minute at 80 lb. pressure with a ⅜ in. sand nozzel, and that it did at least 50 per cent. more work, than a low pressure blast, of well known make did at 20 lb. pressure and ⅜ in. sand nozzle.

As stated before, according to the article, the low pressure machine in question requires 69 cu. ft. free air per minute at 20 lb, which, according to the data given, means 10.99 horse-power, since the 69 cu. ft. of free air is taken from the shop system at 80 lb. by means of a reducing valve. As a matter of fact, it takes almost 13 horsepower to compress this amount of air to 80 lb., and as the high pressure blast, requires 77 cu. ft. at 80 lb., or about 14½ horsepower, the extra 1½ horsepower over the low pressure machine will do over 50 per cent. more work than the latter.

In addition to the above advantage, the high pressure machine in question is constructed in such a way, that the moisture in the air cannot clog the blast or affect the working of the machine; furthermore, there is no sand valve, the sand supply being adjusted by the air valve, which results cannot be obtained in the low pressure, closed hopper type machines. There are other minor advantages in the high pressure machine, which together with the points stated before, give the high pressure blast decided advantange over the old low pressure blasts.

A. E. HOERMANN.

COMPRESSED AIR LOCOMOTIVES IN GERMAN COAL MINES

The circumstance that the compressed air locomotive has become a favorite method of traction in the workings of American collieries has induced one of the large Westphalian coal mining companies, the Kölner Bergwerks Verein, to make an experimental trial of the method in their Emscher pits for a district of workings where the strata are much disturbed, and consequently incapable of a very large daily output. The haulage to be done is equivalent to about 250 ton-miles in the shift of eight hours, the coal be-

ing got from four working places distant 1530, 765, 765, and 875 yards from the pit bottom respectively. The motive power—compressed air—is furnished by a two-stage compressor driven by a direct-current electro-motor of 85 horse-power, which, at 200 revolutions per minute, supplies 159 cubic feet of air at 1500 lb. above the atmospheric pressure. The air so compressed passes by an equalizing reservoir of 35 cubic feet capacity down the shaft to the main haulage road 299 yards below the surface by a line of 1½ in. wrought iron pipes, three other reservoirs of 35 cubic feet each being intercalated in the line at equal distances apart in the levels underground, to serve as filling places for the locomotives, which are supplied through reducing valves at 750 lb. pressure. The principal feature of the locomotive is the main air reservoir, a cylindrical vessel 10 ft. 4 in. long and 33½ in. diameter, of 57 cubic feet capacity, corresponding to 2910 ft. of free air compressed to the working pressure of 50 atmospheres. Below the main air vessel a smaller one is placed, with a reducing valve connection which brings the pressure down to 10 atmospheres, the initial admission pressure in the cylinders. The air vessels and the engine cylinders are carried by longitudinal cast iron framings mounted on a pair of coupled wheels of 19½ in. diameter, and a wheel base of 39.2 in. The total weight in running order is 5 to 6 tons. Under normal working conditions the power developed ranges from 8 horse-power to 12 horse-power with a maximum of 24 horse-power, and the hauling capacity is forty to fifty laden coal tubs of 2180 lb. gross, or 1245 lb. net weight, each moved on an incline of 1 in 300 at 8.2 ft. per second—5.6 miles per hour. With two locomotives at work, hauling from the four different working places, the work done in the shift corresponded to 262 ton-miles, the actual running times for the two engines being 313 min., while 642 min. were accounted for in stoppages and shunting work. The work done by the compressor during its 400 min. of running time corresponded to 374 kilowatt-hours. Under these conditions the total cost of haulage per useful ton-kilometre was 8.59pf., equal to about 3.5 cents per ton-mile. This includes, besides the outlay on power, wages, repairs, lubricating and cleaning materials, interest and sinking fund on the cost of the plant—$8,750.

During a trial extending over seven months the work has been carried on continuously without any interruption of the regular work, as even on one occasion, when the compressor was stopped for twelve hours to replace a defective valve, the engines ran to the end of the shift with the supply contained in the main air vessels without exhausting it. The pressure main has also remained wonderfully tight; the supply reservoir, when filled at 100 atmospheres at 2 p. m. one day, showed a gauge pressure of 93 atmospheres at 5.30 a. m. on the following morning. The general results of the trials may, therefore, be considered as satisfactory, as although, like all compressed air machinery, the mechanical efficiency is somewhat low, and the first cost of the primary power arrangements is decidedly higher than that called for by electric locomotives, the working cost, including wear and tear and maintenance, is considerably lower.—*The Engineer,* London, compiled from *Glückauf.*

UNITED STATES FOREST RESOURCES

The forests of the United States now cover about 550 million acres, or about one-fourth of the land of the whole country. The original forests covered not less than 850 million acres, or nearly one-half.

The forests owned by the government cover one-fourth of the total forest area, and contain one-fifth of all timber standing. Forests privately owned cover three-fourths of the area, and contain four-fifths of the standing timber. Besides having three times the area and four times the forests, the timberland privately owned is generally more valuable.

Forestry, or conservative lumbering, is practiced on 70 per cent. of the forests publicly owned and on less than one per cent. of the forests privately owned. This covers the country's forest resources as they stand to-day. Senator Smoot, chairman of the section of forests of the National Conservation Commission, in outlining the future has said:

"By reasonable thrift, we can produce a constant timber supply beyond our present need, and with it conserve the usefulness of our streams for irrigation, water supply, navigation, and power.

"Under right management, our forests will yield over four times as much as now. We can reduce waste in the woods and in the mill at least one-third, with present as well as future profit. We can perpetuate the naval stores industry. Preservative treatment will reduce by one-fifth the quantity of timber used

in the water or in the ground. We can practically stop forest fires at a total yearly cost of one-fifth the value of the standing timber burned each year, not counting young growth.

"We shall suffer for timber to meet our needs, until our forests have had time to grow we shall escape permanent timber scarcity."—*U. S. Department of Agriculture.*

THE "HOT AIR" CLUB

Responding to an invitation issued by W. L. Saunders, president of the Ingersoll-Rand Company, a number of air compressor builders met on February 8th at Hotel Manhattan, New York, and took the initial steps for the organization of the "Hot Air" Club. It was the general view that there should be some way of meeting and discussing business conditions. Another object will be the study and development of compressed air machinery and the extension of the use of compressed air in industrial operations. It is expected that a permanent organization will be completed at the next meeting. The following are enrolled:

C. L. Newcomb, Rix Compressed Air & Drill Company; George F. Steedman and A. E. Hoerman, Curtis & Co.; J. W. Gardner, Gardner Governor Company; J. E. Friend, Nordberg Mfg Company; G. B. Aldrich, Platt Iron Works; A. R. Johnson and P. C. Blaisdell, Blaisdell Machinery Company; W. L. Saunders, J. P. Grace and J. H. Jowett, Ingersoll-Rand Company; William S. Fairhust, American Air Compressor Works; F. K. Copeland and A. E. Blackwood, Sullivan Machinery Company; J. W. Duntley and J. R. McGinley, Chicago Pneumatic Tool Company; J. Geo. Leyner, J. Geo. Leyner Engineering Works Company; G. Reinberg, T. E. Sturtevant and J. G. Shaw, McKiernan Drill Company; F. H. Jones and J. B. Lapman, International Steam Pump Company; C. W. Warner and Geo. Wainwright, Bury Compressor Company.

RUNNING A TWO-STAGE COMPRESSOR SINGLE STAGE

In the transactions of a South African society it is suggested that where a two-stage compressor is employed, and where at certain times of the day the air is used only for ventilation or blowing out, the low and the high pressure cylinders should be so arranged that each would take in free air and both discharge directly into the main. It is claimed that this would, in most cases, add 50 per cent. to the volume of air delivered, the coal consumption would, for a given volume of air, be reduced one third, while the air, passing through but one cylinder, would take up less oil. There would be no objection to this arrangment if the demand for the low pressure air were sufficiently frequent or protracted. With the usual cylinder ratios, however, the increased air delivery would be under 40 per cent. instead of 50.

SURROUNDING MAIN AIR PIPE WITH A STEAM COIL TO PREVENT FREEZING

By J. J. Newbaker.

We have in use a number of pneumatic tools used for chipping out the seams in steel blooms in order to produce perfect material for the manufacture of seamless tubing. The building in which the work is done is located some distance from the air compressor and the main air pipe between the two buildings is exposed to the cold weather. To heat the air to prevent freezing, it has been customary to surround a section of the air pipe with several steam pipes placed longitudinally therewith. Following out a desire to improve on this method I surrounded the pipe with a spiral coil.

Our machine department declined to undertake the winding of this coil cold on the plea that it was not practical and advised that the work be ordered from a pipe-bending shop. As this would mean considerable delay and extra expense I determined to do the job myself, which I did with entire success as follows: Not having a lathe at hand I used a pipe-threading machine instead. For a mandrel I used a 4-inch pipe 20 feet long, one end of which was held in the chuck of the machine, and the other extending to the rear supported by a forked floor stand. A hole was drilled through the pipe near the machine at a right angle to its axis and the first section of pipe to be coiled, ½ inch outside diameter, was secured to the mandrel by means of an eye bolt passing through this hole and held securely in place by a nut on the opposite end. The pipe extended through the eye bolt 6 or 7 inches and remained straight that far for convenience in connecting to the main steam line. With one helper controlling the machine, another holding a piece of 2x½-inch flat iron on top of the

pipe mandrel to gage the pitch of the coil and two holding back on the pipe to be coiled the machine was started. When the end of the first section of the coil approached within a foot of the mandrel the machine was stopped and another length of pipe attached by means of an ordinary coupling arranged to butt the two pipes squarely in the center and forced solidly together. As the coupling approached the mandrel I heated it on each side with a pneumatic torch to prevent overstrain on the joint, after which the winding proceeded cold as before until the point arrived to attach another section.

This operation was repeated until sufficient coil had been produced for my purpose. The length of the spiral pipe when finished was 13 feet, with a 2¾ pitch, except 16 inches on the last end, which was wound close. The finished coil was perfectly tight under 200 pounds gage pressure. After it was in position on the air line and heated up with steam it was covered first with heavy asbestos paper and finished with plastic pipe covering.—*American Machinist.*

VENTILATION BY INDUCED CURRENTS

At the recent meeting of the Institute of Marine Engineers, Mr. Robert Gregory read a paper bearing the above title. The system described by Mr. Gregory consisted of a nozzle placed in a series of corrugated tubes of different sizes telescoped into one another, and so arranged that at each diminishing diameter an annular space remained between the tubes of sufficient area for the vitiated air to flow in at the junction, thus carrying off the foul air or gases. The nozzle was fitted into the smallest tube, and was connected to an accumulator or reservoir of compressed air, supplied by a small air compressor. Pipes, fitted with a regulating valve, could be carried from the accumulator to each compartment or hold, and there connected to their respective ventilators, which could be used either as downcasts for fresh air or as upcasts for exhausting the foul air. Instead of compressed air a centrifugal fan could be used for supplying air to the nozzles, and by means of hot air chambers the air could be heated for the purpose of warming the cabins or saloons.

PNEUMATIC SIGNALS FOR MINES

The pneumatic system of signalling of the Westinghouse Air-Brake Co., which has been in use for many years on passenger trains, has been introduced at various mines in different parts of America to replace the pull-bell or electric systems. In the Westinghouse apparatus there is only one moving part, i. e., the small lever of the discharge valve. Another advantage is the fact that the signal sender has always the means of knowing whether the signal has been delivered to the engineer. Changes of temperature, likely to occur from change of air currents, do not affect the working of the system. If any accident should injure the signal pipe, or any parts of the apparatus which would allow a part of the air to escape, a warning would at once be automatically given to the engineer.

SOAP FOR AIR COMPRESSOR VALVES

In a paper in the Transactions of the Engineers' Club of Philadelphia dealing with Diesel engine troubles occurs the following:

We have had some trouble with the air compressors in the past. We would grind in the valves and find them a few days later caked with dirt and rust and the seats showing signs of corrosion. That trouble was entirely obviated by the use of one-quarter pint of soapy water in the low-pressure lubricator three times a day. Now we find the seats with a mirror-like polish and clean valves. This may be accounted for in the following way: It is well known that iron does not oxidise rapidly except in the presence of carbon dioxide and moisture. The carbon dioxide in the compressed air, dissolved in the moisture condensed out of the compressed air in the intercooler, and thus formed weak carbonic acid, which in company with the oxygen of the air created excessive oxidation. The alkali in the soap was sufficient to neutralise this carbonic acid and consequently the oxidation did not occur.

TRADE PUBLICATIONS

CROSBY TESTING APPARATUS, Crosby Steam Gage & Valve Company, Boston, 20 pages, 4¾ by 7 inches. Describes gages and pumps for testing for vacuum or for pressures up to the highest.

LUBRICATING THE MOTOR, Joseph Dixon, Crucible Company, Jersey City, N. J., 24

pages 5 by 8½ inches. The pamphlet is divided into chapters which treat in detail on the use of flake graphite in motor service. There is a chapter on tires, also chapters, self descriptive, entitled "Overhauling the Car" and "Motor Boat and Cycle."

ELECTRIC PUMP GOVERNORS, Instructive Pamphlet T 5042, Westinghouse Traction Brake Company, 20 pages, 4¾ by 7 inches. The apparatus described is for automatically controlling the operation of motor driven air compressors between predetermined minimum and maximum air pressures.

NOTES

A pocket aneroid barometer invented by J. C. Asten, Upper Norwood, S. E. Eng., notes differences of elevation of 10 feet up to 10,000 feet. The dial is 2½ in. in diameter.

There is a "dispute" at the Dunkerton, England, colliery, with no prospect of an immediate settlement, the origin of the trouble being a demand of the boys for an additional halfpenny (1 cent) per ton on the standard wages.

Hot-air heating by utilizing the waste heat of a gas engine is a feature at a Pennsylvania manufacturing plant. Both the exhaust gases and the jacket cooling water are used to heat fresh air, which is circulated by a fan.

In one district in Canada, the mine managers have found it advisable from the standpoint of economy, to have their ventilating fans so constructed that they can run them one way in summer and the reverse in winter.

The Government Mining Engineer reports that there are installed on the Rand, South Africa, 186 air compressors, having an aggregate I. H. P. of 72,400, a free air capacity of 600,000 cu. ft. per min., and costing $3,750,000 per annum to operate under normal conditions.

Small air hoists mounted on a bar are used in some of the mines at Mount Morgan, New South Wales, Australia. These are easily put up, the bar being placed vertically, and are used instead of a windlass in sinking winzes. These hoists are simple in contruction, are light and can be moved easily.

Compressed air is so ready and alert to do things, and does so many things so creditably that new stunts are being proposed for it continually, not always by those most familiar with its successful employment. A man in Ohio has a patent for blowing people off railroad tracks to avoid running over them.

While most people know that Pliny states that the ancients broke ore in mines by pouring vinegar on the heated face of rock, it is less generally known that he further states that they also used bars of iron as battering rams to break the ore from the face. These bars were heavy and several miners were required to each battering ram.

The English Admirality have experimented with an ingenious device comprising a small motor air pump for the detection of dangerous gases on board submarines. The pump stationed at an indicator draws air through pipes laid to various parts of the boat, and should dangerous gases exist, warning is given by a delicate recorder.

The Mexican government has appropriated $50,000 for a monument to Jesus Garcia, a locomotive engineer employed in the railroad yards at Nacozari, Sonora, who, on Nov. 7, 1907, hooked his locomotive to a burning car of dynamite and pulled it out of the town. He was blown to death, but his act saved the town and many lives.

A miner's inch of water, or that quantity which will flow through an opening an inch square with a head of four inches above the opening, will irrigate from five to ten acres of land for agricultural purposes. This is equal to a flow of about 13,000 gallons in 24 hours. Fifty miner's inches equal a flow of one cubic foot of water per second.

The area of the more accessible coal-fields of the United States is about 327,000 square miles, and they carry an estimated content available for future use of nearly 2000 billion tons. The rate of consumption cannot be predicted with certainty, but if the rate of increase that has held for the last 50 years is maintained the supply of easily available coal will be exhausted before the middle of the next century.

An engine built in 1808, or over a hundred years ago, for a British firm, has just failed by the breaking of the crank shaft. The company which built the engine has been called upon to make repairs, and after an examination of the rest of the engine, it was found to be in excellent condition, so that it has been concluded to set it to work again as soon as the repairs have been completed.

Announcement is made of the consolidation of the American Blower Company, of Detroit, and the Sirocco Engineering Company, of New York. The plants at Detroit, Mich., and Troy, N. Y., will continue in full operation and all business will be transacted under the style and name of the American Blower Company (Incorporated under the Laws of the State of New York).

When certain patents expire next year the manufacture of aluminum will be open to whoever may choose to engage in it, and the chances are that the industry will make enormous strides in the next few years. In Europe the patents expired last year and the metal is selling about 13 cents a pound. The duty into the United States is 8 cents and here the price is about 23 cents.

The C. & G. Cooper Company, Mt. Vernon, Ohio, has received a contract from the Tennessee Coal, Iron & Railroad Company for a 3,000-hp. cross compound Corliss steam engine, to be installed in its electrical power house at Ensley, Ala. The cylinder dimensions are 42 and 78 x 54 in. The engine is arranged for direct driving a 2,500-kw. Crocker-Wheeler alternator. The unit will operate at 83½ rev. per min. and be capable of developing 4,500-hp. continuously when necessary.

There recently occurred near Mauch Chunk, Pa., the largest cave-in that has ever been known in the anthracite coal region. The side of the mountain over the Panther Creek Mine of the Lehigh Coal & Navigation Company caved in. This mine has been on fire in the heart of the mountain for forty years and the company has spent large sums in trying to extinguish it. The burning away of the coal has eaten out the support for the surface. It is said that the sound of the collapse was heard for twenty miles.

To show how great may be the generation of static electricity in German factories, Prof. M. M. Ritcher has drawn sparks 1 in. to 1½ in. long from a 5-in. belt on a wheel making 1,000 revolutions a minute. The risk of explosion in dust or gases seems to have been overlooked. Coating with bronze or aluminum powder prevented static charges, while a weekly application of acid-free glycerine was a remedy and added durability to the leather.

The average yield of peanuts in oil, according to quality and origin, is from 38 to 50 per cent. of their weight. The first pressure gives from 16 to 18 per cent. of high-grade edible oil; the second, from 7 to 8 per cent. of second grade, after which from 7 to 10 per cent. of industrial oil is also obtained. The remaining cake is often also treated by the sulphur of carbon or tetrachlorure of carbon process, which extracts a further 7 to 10 per cent. of low-grade industrial oil.

If a conscientious housewife suspects that the fresh green of her canned vegetables is due to the presence of copper in the goods [bads?] the quantity of copper may be determined by incinerating the vegetables, leaching the ash with nitric acid, evaporating to dryness, dissolving the residue in hydrochloric acid, neutralizing the solution with ammonia, acidifying it slightly with hydrochloric acid, and precepitating the copper with zinc in a vessel of platinum.

A new alloy has been brought out in France, known as Invar, which has the valuable property of having practically no expansion; it also is not magnetic, and it does not rust, it being thus specially adapted for various purposes. Nickel steel is the base of the alloy, and up to 20 per cent. of nickel, the expansion is about the ordinary. It then increases up to a value of 24 per cent., reaching a minimum value at 36 per cent. of nickel, then rising and taking the normal value for a 50 per cent. alloy. It is the 36 per cent. metal which has the curious properties, and its expansion is almost zero,

being 17 times less than that of steel and about the same as for melted quartz.

That air brake hose gets hard in cold weather is generally due to freezing. If we could get some kind of rubber that would not freeze we would be very happy. Crude rubber will freeze at about 20 degrees F., and vulcanized rubber freezes at about zero. All rubber companies have experimented in different ways to prevent this, and they have added oils and all kinds of things that do not freeze so readily, but in this country the temperature gets so low that it frequently gets beyond us.

No snake will tackle a hair rope. It is the only sure protection against them. Somehow this idea has permeated the minds of the East Indians and now they buy these ropes for protection against the poisonous snakes with which that country abounds. Large numbers of these ropes are shipped to India and adjoining countries each year. Over there they are coiled on the floor around the bed at night and the occupant can lie down in comfort, certain that no snake will ever attempt to pass over that hair rope. It is about the only way any one can be sure of a night's sleep undisturbed by visits from snakes in that country.

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D C.

JANUARY 5.

908,445. PNEUMATIC GRAIN-CONVEYER. WILLIAM F. CARLTON, Advance, Mo.

908,515. PNEUMATIC HAMMER. HARRY B. STOCKS, Didsbury, Manchester, and JOHN R. WEBB, JR., East Cliffe, Dover England.

908,644. APPARATUS FOR LIQUEFACTION OF GASES AND SEPARATION OF AIR INTO COMMERCIAL OXYGEN AND NITROGEN. GABRIEL A. BOBRICK, Los Angeles, Cal.

908,690. DIVING-GEAR OR THE LIKE. ALOIS NEUBERT, New York, N. Y.

908,692. AUTOMATIC GOVERNOR FOR AIR-COMPRESSORS. CLARENCE NORLAND, Los Angeles, Cal.

908,794. AERONAUTIC APPARATUS. GEORGE A. METCALF, Malden, Mass.

908,866. AIR-LOCK. HENRY JAPP, New York, N. Y.

908,869. DUMPING-VEHICLE. JOHN W. KING, New York, N. Y.

4. In a vehicle, a supporting frame, a dumping body thereon, means adapted to automatically lock said body in normal position, fluid actuated pistons and means actuated by said pistons adapted to unlock the body previous to imparting movement thereto, positively move it horizontally and allow it to dump of its own momentum and then positively return it to normal position substantially as described.

908,877. APPARATUS FOR RECEIVING SUBMARINE SIGNALS. CHARLES H. MUNDY, Metuchen, N. J.

908,920. MOTOR-ACTUATED HAND-TOOL. WILLIAM C. WHITCOMB, Chicago, Ill.

908,921. MOTOR-ACTUATED HAND-TOOL. WILLIAM C. WHITCOMB, Chicago, Ill.

908,922. MOTOR. WILLIAM C. WHITCOMB, Rochelle, Ill

908,963. HUMIDIFYING AND AIR-MOISTENING APPARATUS. STUART W. CRAMER, Charlotte, N. C.

908,964. HUMIDIFIER AND AIR-MOISTENING APPARATUS. STUART W. CRAMER, Charlotte, N. C.

908,968. PNEUMATIC CALLIOPE. SAMUEL V. DAY, Whichita, Kans.

908,991. ANIMAL-CLEANING APPARATUS. CONRAD HAMMER, Buffalo, N. Y.

908,992. PORTABLE VACUUM DUST-EXTRACTOR. CHARLES J. HARVEY, Kidderminster, England.

909,056. TRACK-SANDER. JOHN W. BRADY, Neodesha, Kans.

JANUARY 12.

909,163. COMPOUND PUMP. JOHN DESMOND, Chicago, Ill.

909,183. VACUUM-PUMP. CHARLES L. HEISLER, St. Marys, Ohio.

909,259. ROCK-DRILLING ENGINE. JOHN A. TRAYLOR, Denver, Col.

909,373. PRESSURE-CONTROLLING VALVE FOR TIRE-PUMPS. JOHN DESMOND, Chicago, Ill.

909,397. BALLON OR AIR-SHIP. ALEXANDRE F. GODEFROY, Mexico, Mexico.

909,427. VARIABLE-VOLUME AIR-COMPRESSOR. MAX KURTH, Franklin, Pa.

909,551. SIGNAL APPARATUS. CLYDE J. COLEMAN, Rockaway, N. J.

1. In a railway signal apparatus the combination of a signal nomally at safety, and having a normal bias to danger, a pressure storage tank containing *liquefied gas*, and a gas pressure-applying chamber in operative connection with said signal, and in controllable communiciation with said storage tank, whereby gas may be supplied from said storage tank to said gas pressure-applying chamber to move the signal to safety, substantially as described.

909,632. AIR-HEATER. AUGUST MATHIS, Chicago, Ill.

909,681. AIR-SHIP. WILLIAM RUMBLE, New York, N. Y.

909,740. PNEUMATIC-TOOL LUBRICATOR. JOHN C. BECKFIELD, Pittsburg, Pa.

909,790. PNEUMATIC-TOOL COUPLING. ALEXANDRE HERBERT, Montpelier, Vt.

909,809. AIR-BRAKE SYSTEM. HERMAN W. LEY, Boulder, Colo.

JANUARY 19.

909,907. AIR OPERATED AND CONTROLLED MECHANISM. JAMES S. JOHNSTON, Utica, N. Y.

909,923. VALVE MECHANISM FOR ROCK-DRILLS, &c. JOSEPH L. MITCHELL, Denver, Colo.

909,950. TESTING APPARATUS. FRANK SCHREIDT, Mansfield, Ohio.

910,036. TURBO-BLOWER, ALBERT L. WOLFSON, New York, N. Y.

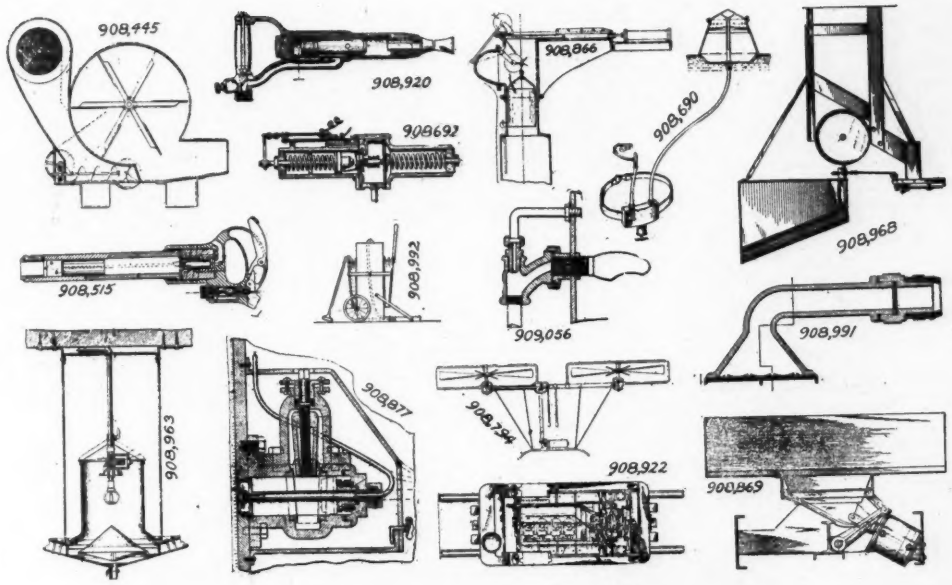
910,045. AIR-WASHER. FRANK E. DONALDSON, Chicago, Ill.

910,175. ROTARY COMPRESSOR. HENRY W. N. COLE, Brooklyn, N Y.

910,223. THROTTLE-VALVE FOR PNEUMATIC HAMMERS. REINHOLD A. NORLING, Aurora, Ill.

910,224. REVERSIBLE DRILL-THROTTLE. REINHOLD A. NORLING, Aurora, Ill.

910,277. APPARATUS FOR ELEVATING GOLD-BEARING DEPOSITS FROM RIVER-BEDS, ALBERT L. ELIEL, San Francisco, Cal., and OSCAR H. ELIEL, La Salle, Ill.



PNEUMATIC PATENTS, JANUARY 5.

1. An open-ended, vertically-arranged, hollow shaft and a frame in which the said hollow shaft is mounted so as to slide vertically, in combination with mechanism for moving said hollow shaft vertically and horizontally and imparting to it reciprocating rotary movement and an air tube connected with the bottom end for introducing compressed air into said hollow shaft when partially submerged.

910,341. AIR-BRUSH. OLAUS C. WOLD, Chicago, Ill.

910,342. AIR-MOTOR. DANIEL B. WOOD, Almyra, Ark.

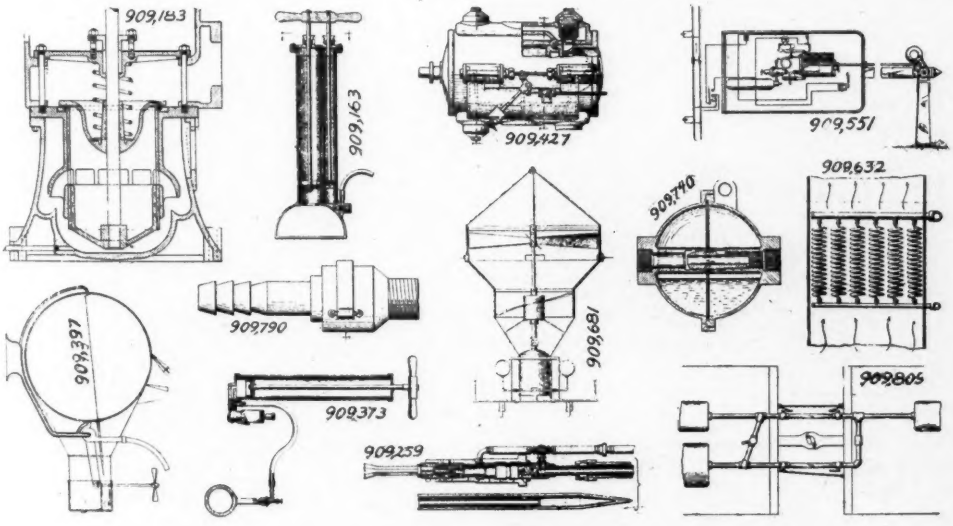
910,373. PNEUMATIC CLOCK SYSTEM. AUGUSTUS L. HAHL, Chicago, Ill.

910,402. AIR-BRAKE SYSTEM. GEORGE MACLOSKIE, Schenectady, N. Y.

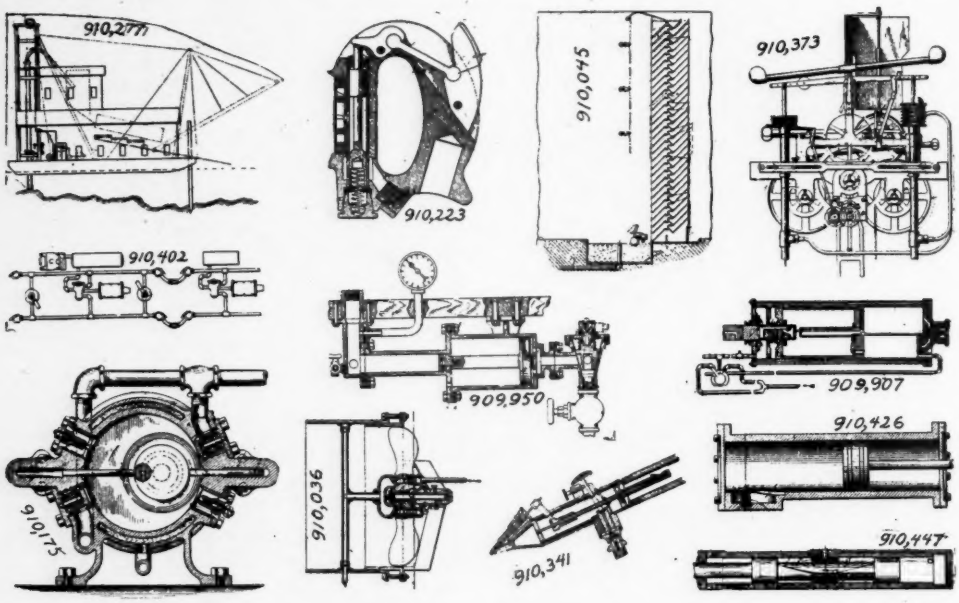
910,426. FLUID-PRESSURE HOIST. EARL D. SMITH, Delphi, Ind.

910,428. TURBO-PNEUMATIC DRILL. JOHN W. SMITH, Philadelphia, Pa.

910,447. DISTRIBUTING-VALVE FOR PERCUSSIVE ROCK-DRILLING MACHINES. ANTHONY J. BANT and HENRY GULLETT, Johannesburg, Transvaal.



PNEUMATIC PATENTS, JANUARY 12.



PNEUMATIC PATENTS, JANUARY 19.

JANUARY 26.

910,488. AERIAL NAVIGATING APPARATUS. JOHN BERNARD, Richmond, Va.

910,500. TUNNELING-MACHINE. CHARLES A. CASE, New York, N. Y.

910,525. METHOD OF AND APPARATUS FOR DRYING AIR. HORACE C. GARDNER, Chicago, Ill.

910,560. PERCUSSION-MACHINE. WILHELM MAUSS, Brakpan, Transvaal.

910,683. AIR-SHIP. PAUL HOCHSTRASSER, Salt Lake City, Utah.

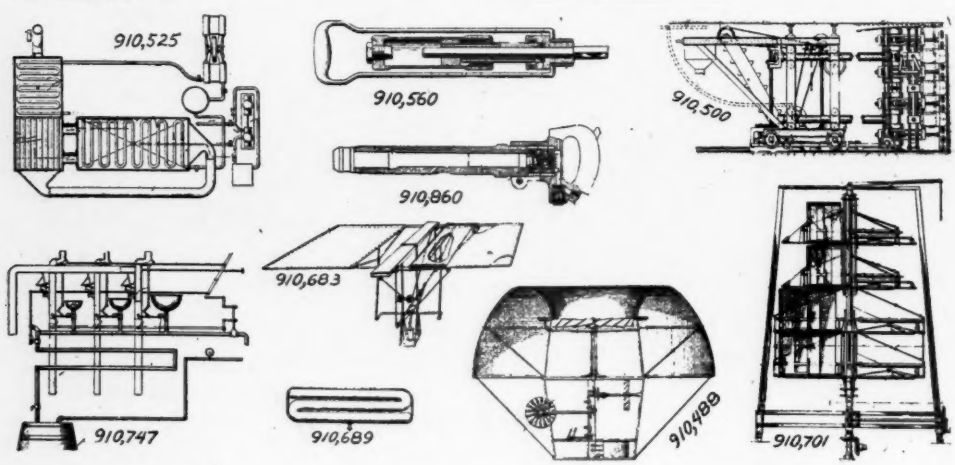
910,689. PNEUMATIC PAD FOR HARNESS. JAMES M. KELLY and FRANK L. RANKIN, Greensburg, Ind.

910,701. WINDMILL. ANASTASIOS MACRIS, Juneau, Alaska.

910,747. LIQUID-VENDING APPARATUS. FREDDIE TURNER, Marquisville, Iowa.

1. The combination with a liquid receptacle, and means for admitting compressed air thereto, of a series of measuring cups, a liquid service pipe leading from said receptacle, a series of branch pipes leading from the service pipe to the measuring cups, a normally closed valve for each of said branch pipes, and means for selectively operating said valves to control the admission of liquid from the service pipe to said measuring cups.

910,860. IMPACT-TOOL. CHARLES B. RICHARDS, Cleveland, Ohio.



PNEUMATIC PATENTS, JANUARY 26.